SECTION 1A
NEW JERSEY TURNPIKE GEOMETRIC DESIGN

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SECTION 1A

NEW JERSEY TURNPIKE GEOMETRIC DESIGN

1A.1 GENERAL

The geometric design criteria contained herein were developed by the Authority for its own particular needs. They are intended to equal or exceed standards currently being used for limited access highways and should be considered minimum criteria and increased wherever economically feasible. The use of substandard criteria, including absolute minimum / maximum values listed in this manual, shall require a Design Element Modification Request subject to approval by the Authority's Engineering Department. For any items not adequately outlined in this section, the Engineer should refer to the latest edition of AASHTO *A Policy on Geometric Design of Highways and Streets* and AASHTO *Roadside Design Guide*.

The design criteria presented is intended to be used as an aid toward sound engineering design. When individual circumstances arise that are not specifically covered, engineering judgment is to be exercised that represents the intent of the criteria shown. The overall objective should be an aesthetically pleasing and safe design that is geometrically compatible in all respects.

1A.1.1 Design Controls

The following design controls shall be applicable on all Turnpike roadways:

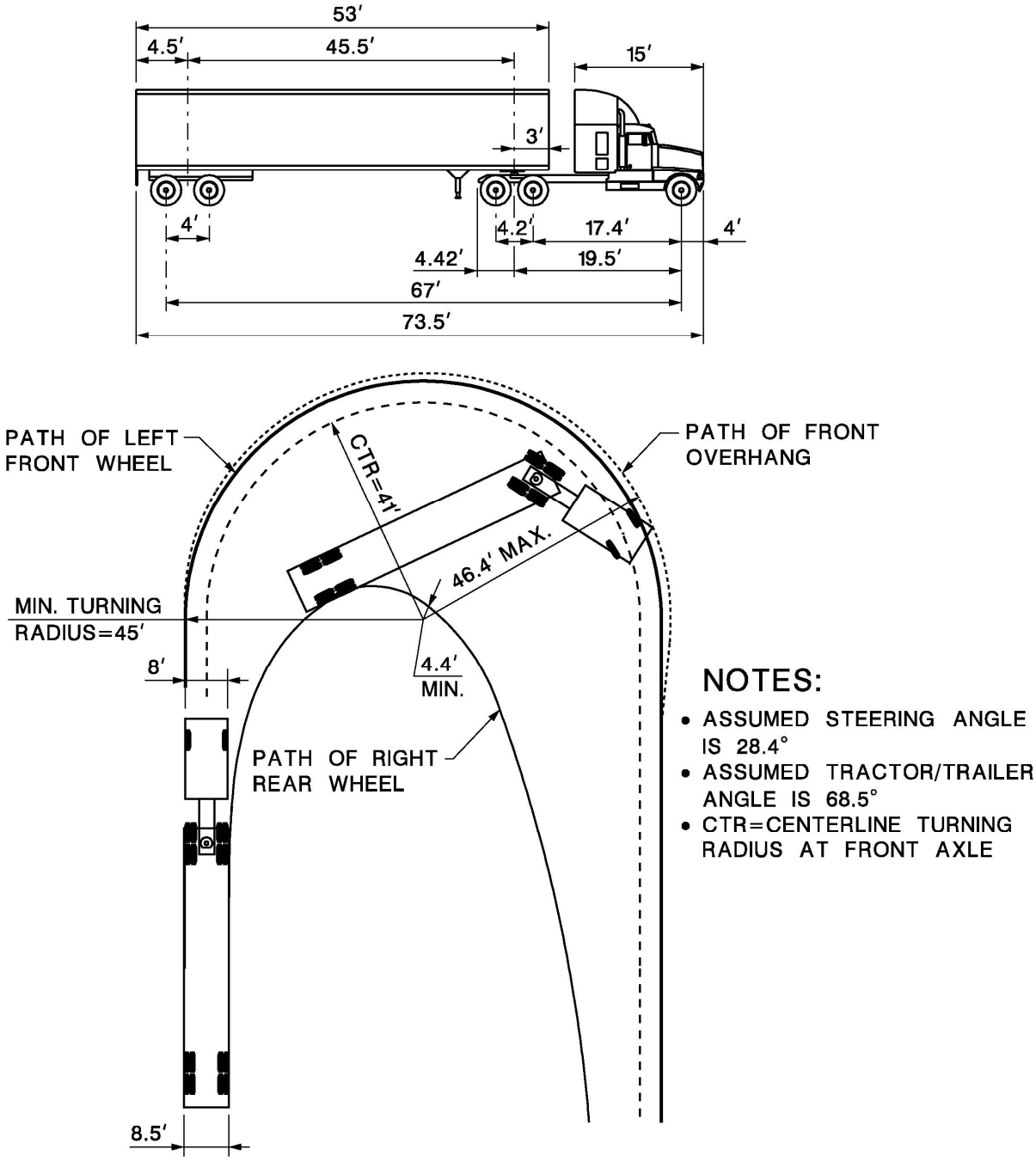
1. Design Vehicle
   Design Vehicle WB – 67 (Interstate Semi-trailer) shall control geometric design. See Exhibit 1A - 1.

2. Clearances

   a. Horizontal - Minimum 4 feet clear of paved left or right shoulder edge to obstruction with appropriate roadside protection (see Section 3 of this Manual).

   b. Vertical - Minimum vertical clearances shall be maintained over all roadways, including shoulders. Verification of all clearances shall be made with the controlling agency.
      i. Roadway over Turnpike - 15 feet minimum or existing vertical clearance, whichever is greater. When resurfacing or widening under an existing bridge whose vertical clearance is less than 15 feet, the existing vertical clearance must be maintained as a minimum.
      ii. Turnpike over any other Road - as required by agency having jurisdiction.

EXHIBIT 1A - 1
WB-67 (INTERSTATE SEMI-TRAILER) DESIGN VEHICLE



3. Sight Distances
   Horizontal and vertical sight distance shall be investigated to ensure that the minimum stopping sight distances as shown in Exhibit 1A - 3 and Exhibit 1A - 22 (horizontal) and Exhibit 1A - 8 and Exhibit 1A - 28 (vertical) are met or exceeded.

   a. Horizontal - Sight distance shall be investigated using one or both of the methods listed below.

i. Where obstruction and vehicle are located within the limits of a simple curve:

$$HSO = R - \sqrt{R^2 - (S/2)^2}$$

Where:

s = Stopping sight distance, ft

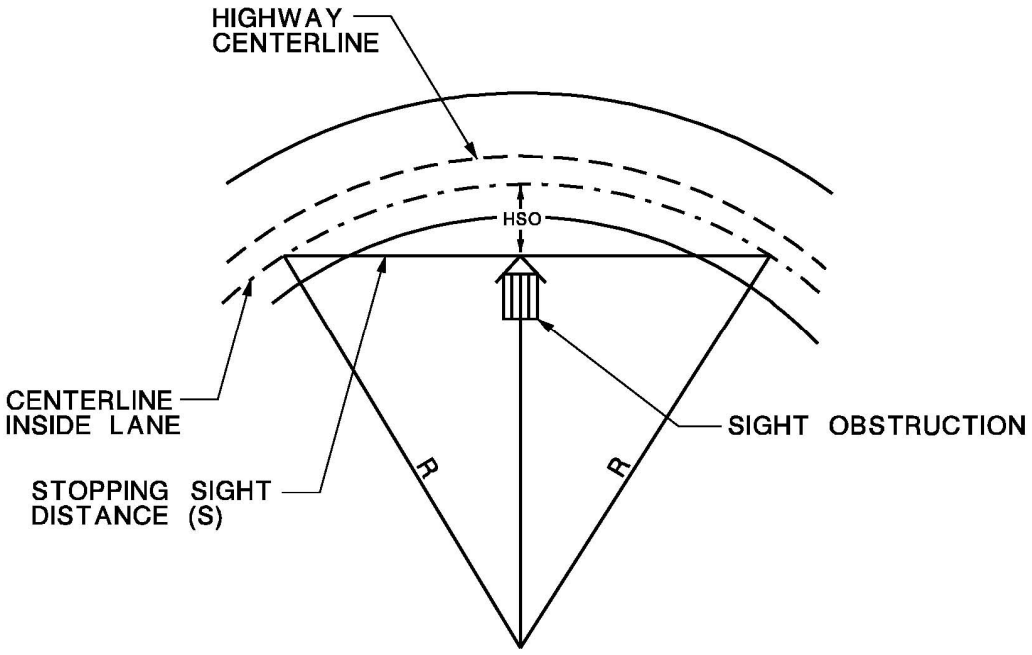
R = Radius of curve, ft

HSO = Horizontal sightline offset, ft

ii. Where the vehicle, the obstruction, or both are situated beyond the limits of a simple curve or within the limits of a compound curve, the design should be checked by utilizing graphical procedures.

b. Vertical - The sight distance for crest curves shall be based on a height of eye of 3.5 feet to an object 6 inches high. The sight distance for sag curves shall be based on headlight sight distance using a headlight height of 2.0 feet and a 1-degree upward divergence of the light beam from the longitudinal axis of the vehicle.

EXHIBIT 1A - 2
COMPONENTS FOR DETERMINING HORIZONTAL SIGHT DISTANCE



1A.2 MAINLINE ROADWAYS

1A.2.1 Roadway Designation

All mainline roadways shall be designated such that the origin and then the destination of that roadway are given in order, (from the north to the south - NS roadway, or from the south to the north, inner roadway - SNI). See Subsection 1.4.1 of the Procedures Manual for a complete listing.

1A.2.2 Design Speed

The design speed for mainline roadways shall be 70 mph south of Milepost 97.0 and 60 mph north of Milepost 97.0. In areas south of Milepost 97.0 where the vertical alignment is controlled by the existing Turnpike profile or other restrictions, the absolute minimum allowable design speed is 60 mph.

1A.2.3 Stopping Sight Distance

The minimum stopping sight distance is the distance required by the driver of a vehicle, traveling at a given speed, to bring his vehicle to a stop after an object on the road becomes visible. Stopping sight distance is measured from the driver's eyes, which is 3.5 feet above the pavement surface, to an object 6 inches high on the road. An object height of 2 feet may be used with Authority approval. The minimum stopping sight distance for mainline design speeds shall be as shown in Exhibit 1A - 3, and Exhibit 1A - 8 for minimum K values.

EXHIBIT 1A - 3
MINIMUM STOPPING SIGHT DISTANCE FOR MAINLINE ROADWAYS

Design Speed (mph)	Minimum Stopping Sight Distance (ft)
60	570
70	730

1A.2.4 Horizontal Alignment

1. Radii
   The minimum radius curve shall be 3,500 feet for 70 mph design speed and 3,000 feet for 60 mph. It is desirable to use as large a radius as geometric controls reasonably permit.

2. Compound Curves
   The ratio of the flatter radius to the sharper radius shall not exceed 1.5:1.

3. The desirable minimum length of curve shall be 1,050 feet for 70 mph design speed, and 900 feet for 60 mph design speed. Absolute minimum length of curve shall be 600 feet.

4. The minimum tangent distance between reversed curves shall be 1,000 feet. The absolute minimum tangent length shall be sufficient to accommodate the superelevation transitions between the reversing curves.

5. The desirable minimum tangent distance between broken back (same direction) curves shall be 2,500 feet. Absolute minimum shall be 1,500 feet.

6. A standard taper rate of 1:100 shall be used for all lane width reductions and lane drops.

1A.2.5 Superelevation

1. Mainline superelevation rate shall be determined from Exhibit 1A - 4 based on a maximum superelevation rate of 5%.

   a. For mainline profile grades less than 0.5 percent, the minimum roadway cross slope shall be increased from 1.5 to 2 percent. Where median barrier is present in this situation, the normal median cross slope as shown in Exhibit 1A - 17 shall be transitioned between 2 and 5 percent to direct drainage flow along the barrier and into storm drains at localized low points along the median. Where profile grades less than 0.5 percent occur in a superelevated section of the mainline with median barrier, the median cross slope transition shall be limited by the maximum rollover values indicated in Exhibit 1A - 16.

   b. If a design assignment involves modification or resurfacing of an existing roadway, the rate of superelevation to be used shall normally follow the current standard, as described in this section. However, if a bridge deck falls within the horizontal curve and the deck superelevation is not being upgraded, the rate of superelevation for the entire length of the horizontal curve shall not exceed that on the existing bridge deck.

EXHIBIT 1A - 4
MINIMUM MAINLINE ROADWAY RADII FOR DESIGN SUPERELEVATION RATES, E_{MAX}= 5%

e_d (%)	V_d = 60 mph $R_{(ft)}$	V_d = 70 mph $R_{(ft)}$
1.5	11100	14100
2.0	8060	10300
2.2	7230	9240
2.4	6540	8380
2.6	5950	7660
2.8	5440	7030
3.0	4990	6490
3.2	4600	6010
3.4	4250	5580
3.6	3940	5210
3.8	3650	4860
4.0	3390	4550
4.2	3140	4270
4.4	R_{MIN} = 3000	4010
4.6		3770
4.8		3550
5.0		R_{MIN} = 3500

2. Tangent to Curve Transition

   a. The minimum length of superelevation runoff (length of roadway needed to accomplish the change in outside-lane cross slope from zero to full superelevation or vice versa) shall be determined from the following equation:

$$L_r = \frac{(wn_1)e_d}{\Delta}(b_w)$$

Where:

L_r = Minimum Length of superelevation runoff (ft)

Δ = Maximum relative gradient (%). See Exhibit 1A - 5.

n_1 = Number of lanes rotated

b_w = Adjustment factor for number of lanes rotated. See Exhibit 1A - 6.

w = width of one traffic lane (ft)

e_d = design superelevation rate (%)

b. The minimum tangent runout length (length of roadway needed to accomplish the change in outside-lane cross slope from the normal cross slope to zero or vice versa) required to remove adverse crown shall be determined from the following equation:

$$L_t = \frac{e_{NC}}{e_d} L_r$$

Where:

L_t = Minimum length of tangent runout (ft)

e_{NC} = Normal cross slope rate (%)

e_d = Design superelevation rate (%)

L_r = Minimum length of superelevation runoff (ft)

c. The location of the superelevation runoff length with respect to the point of curvature (PC) shall be as shown in Exhibit 1A - 5 when conditions allow:

EXHIBIT 1A - 5
MAXIMUM RELATIVE GRADIENT (MAINLINE)

Design Speed (mph)	Maximum Relative Gradient %
60	0.45
70	0.40

EXHIBIT 1A - 6
ADJUSTMENT FACTOR FOR NUMBER OF LANES ROTATED

Number of Lanes Rotated n_1	Adjustment Factor b_w	Length Increase Relative to One Lane Rotated ($=n_1 b_w$)
1	1.00	1.0
1.5	0.83	1.25
2	0.75	1.5
2.5	0.70	1.75
3	0.67	2.0
3.5	0.64	2.25
4	0.63	2.50

EXHIBIT 1A - 7
LOCATION OF SUPERELEVATION RUNOFF (MAINLINE)

Design Speed (mph)	Portion of Runoff Located Prior to the Curve			
	No. of Lanes Rotated			
	1.0	1.5	2.0 – 2.5	3.0 – 3.5
60 – 70	0.70	0.75	0.80	0.85

If the specific values listed above are not attainable for a given location, then the portion of superelevation runoff prior to the PC shall fall within the range of 0.60 to 0.90.

1A.2.6 Vertical Alignment

1. Grades

   a. Desirable maximum profile grade shall be 3 percent. Absolute maximum profile grade shall be 5 percent. Desirable minimum profile grade shall be 0.5 percent. Absolute minimum profile grade shall be 0.3 percent. See Subsection 1A.2.5 for superelevation with less than 0.5 percent profile grade.

   b. Desirable minimum length of profile tangent shall be 1,000 feet. Absolute maximum length of vertical tangent shall be dictated by a maximum permissible loss in truck speed of 10 mph.

2. Vertical Curves

   a. The minimum length of vertical curve shall be determined as follows:

      $L = AK$

      Where:

      L = Length of vertical curve, in increments of 25 feet where feasible.

      A = Algebraic difference in grades entering and leaving vertical curve.

      K = Horizontal distance in feet required to effect a 1 percent change in gradient. See Exhibit 1A - 8. The minimum value of K shall accommodate the minimum stopping sight distance along the vertical curve based on the criteria for investigating vertical sight distance established in Subsection 1A.1.1.

   b. The PVI (point of vertical intersection of two grades) station shall be located at an even 25-foot station increment where feasible.

   c. For an “A” less than or equal to 0.25 percent, an angle point shall be established, and no vertical curve used.

EXHIBIT 1A - 8
DESIGN CONTROLS FOR MAINLINE ROADWAY VERTICAL CURVES

Design Speed (mph)	Stopping Sight Distance (ft)	Crest K	Sag K
	Minimum		
60	570	245	136
70	730	400	181

1A.2.7 Pavement

The mainline pavement section shall be constructed as shown on Exhibit 1A - 9. Current pavement mix types to be used for each of the courses shown in the pavement sections shall be as directed by the Authority.

1. Embankment, Grade A, shall be a minimum of 18 inches deep under travel lanes. In locations where existing pavement is widened, Grade A material is to be deeper, if necessary, to match template grade of existing pavement. Template grade (top of subgrade below Grade A embankment) shall slope transversely a minimum of 2% or match cross slope of roadway. Template grade shall be constructed transversely under the full section, without breaks in cross slope, on each individual roadway and in such a manner as to provide positive drainage (daylight section or underdrains).

2. In areas where existing and currently designed resurfacing depth approaches 12 inches, or more, at the existing pavement / shoulder interface, investigations shall be made as to the feasibility of leaving the existing shoulder in place as a portion of the proposed pavement section.
3. At interfaces between Turnpike pavement and the pavement of outside agencies, the higher-class pavement shall be constructed first, with offset and steps per course as shown. Account for offset and stepping quantity computations.

4. The various pavement interface and stepping details shown on Exhibit 1A - 10 through Exhibit 1A - 14 are for Turnpike pavement. Adjust steps accordingly to match other pavement sections. Account for stepping quantity computations. With curb, courses terminate at curb face as shown, any stepping shall be from back of curb.

5. In the pavement interface details shown on Exhibit 1A - 13, the existing pavement is from the 1985-90 widening construction. Each area shall be reviewed and adjusted to conform with existing construction. Where proposed widening includes resurfacing the adjacent existing pavement, omit the 6-inch removal of the top course and place the new surface course pavement joint at least 2 feet from the existing edge of pavement.

6. When computing quantities for asphaltic concrete items, the following conversion factors are to be used for preliminary estimates and are to be verified for each project prior to completion of the final quantities.

Surface Course	156.0 ± lb/cuft.
Intermediate Course	157.5 ± lb/cuft.
Base Course	159.0 ± lb/cuft.

7. Tack coat shall be applied to all existing (milled) pavement surfaces just prior to asphalt resurfacing. Tack coat shall also be applied to all exposed cut surfaces of an existing asphalt pavement section which is stepped to interface with a proposed pavement section. Tack coat will not be required between subsequent asphalt layers of proposed pavement unless:

   a. The underlying layer has been contaminated.

   b. The underlying layer has been exposed to prolonged traffic use.

   c. It is otherwise required on the drawings or in special provisions.

8. Hot mixed asphalt pavements shall be constructed in accordance with the Standard Specifications, as amended by the Supplemental Specifications. Surface and intermediate courses for Turnpike Pavement shall each be placed in a single lift. The base course for Turnpike Pavement shall be placed in two lifts. Pavement course lifts shall conform to the following:

   a. The minimum lift thickness shall be three times the nominal maximum aggregate size of the specified pavement mix type.

   b. The maximum lift thickness shall be five times the nominal maximum aggregate size of the specified pavement mix type.

   The above lift requirements shall apply to U-Turn and Car Parking pavement sections, as well as any variations of Turnpike Pavement used in resurfacing / re-grading projects.

EXHIBIT 1A - 9
TURNPIKE PAVEMENT (MAINLINE, RAMP & SHOULDERS)

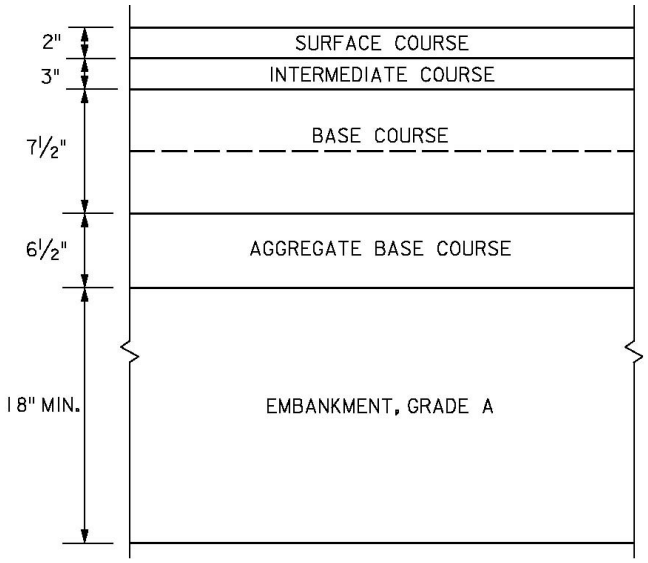


EXHIBIT 1A - 10
PAVEMENT REMOVAL AND RECONSTRUCTION DETAIL

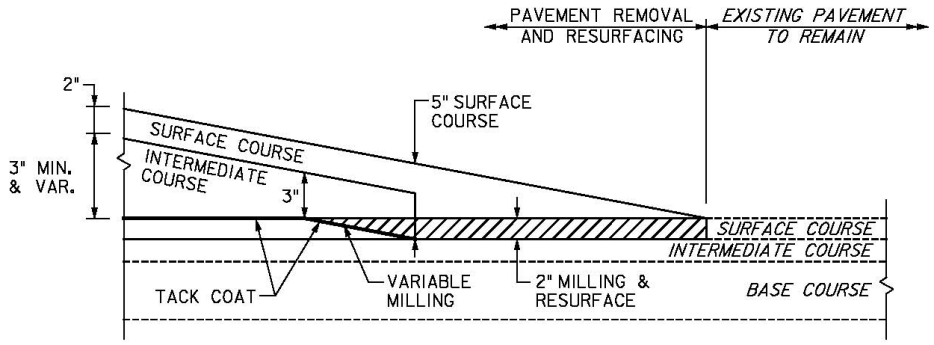


EXHIBIT 1A - 11
LONGITUDINAL PAVEMENT STEPPING DETAIL

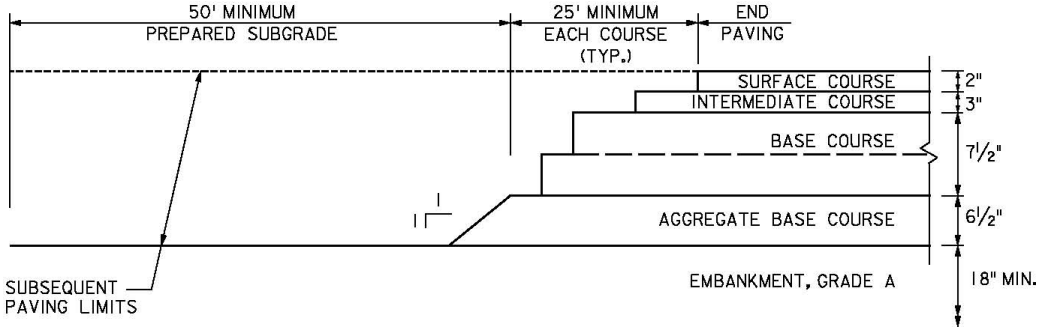
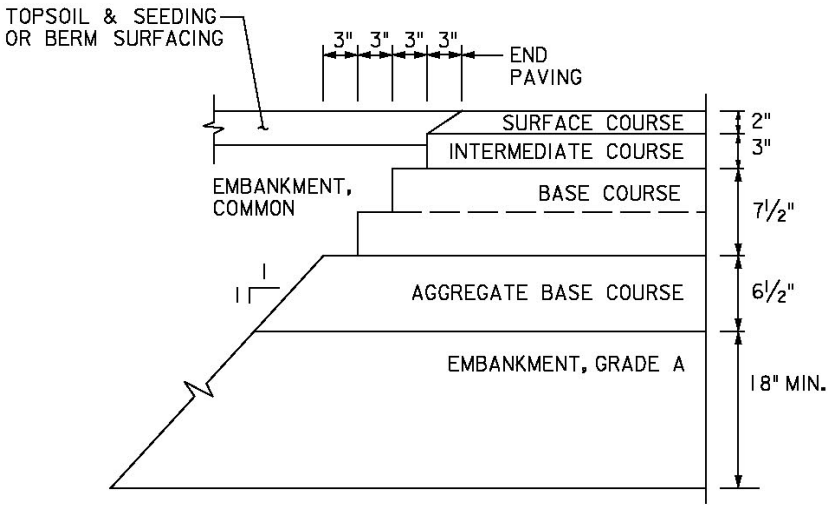
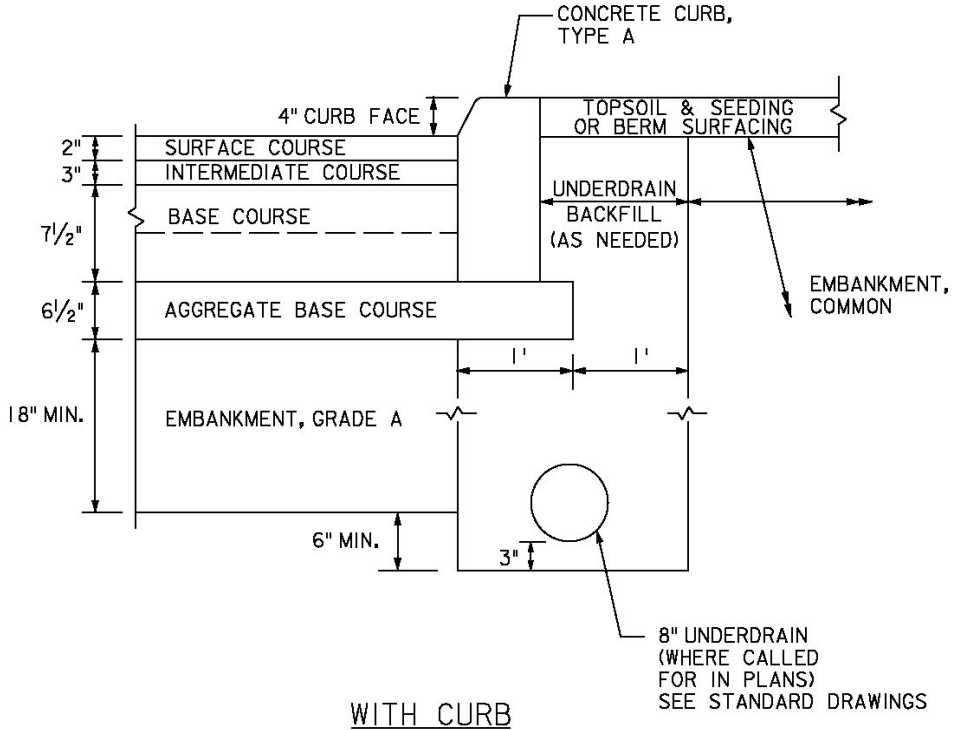


EXHIBIT 1A - 12
TRANSVERSE PAVEMENT STEPPING DETAIL



WITHOUT CURB



WITH CURB

NOTES:

1. BASE COURSES OVER 4" THICK SHALL BE INSTALLED IN TWO LIFTS.

EXHIBIT 1A - 13
NEW PAVEMENT INTERFACE WITH EXISTING PAVEMENT

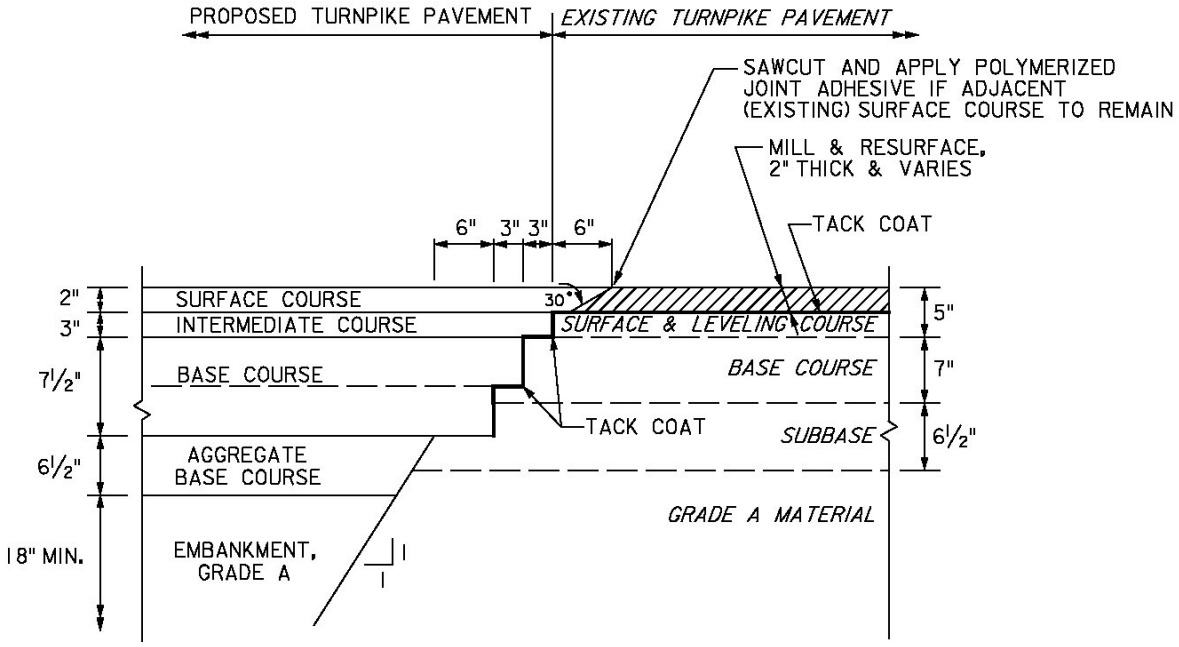
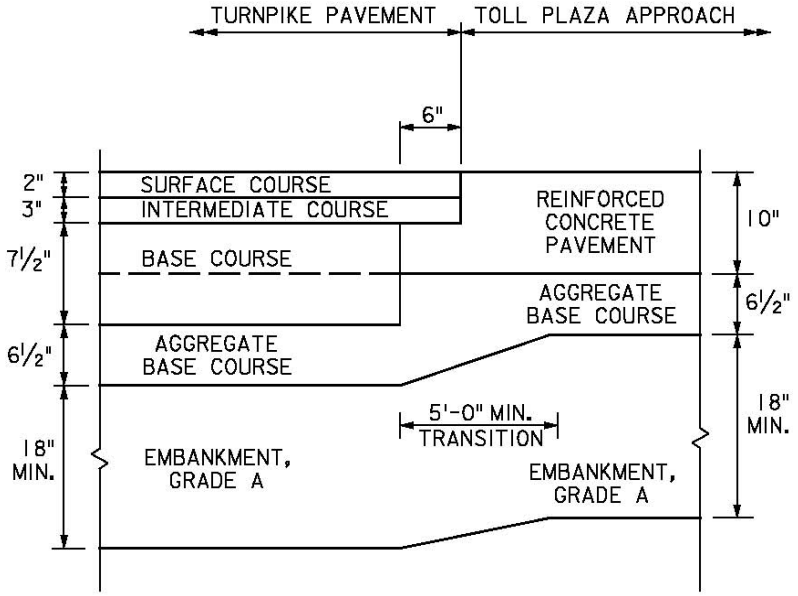


EXHIBIT 1A - 14
TOLL PLAZA PAVEMENT INTERFACE



1A.2.8 Typical Section

1. For typical mainline roadway dimensions and cross slopes for normal and superelevated sections, see Exhibit 1A - 15 and Exhibit 1A - 16.

2. Rumble Strips
   Rumble strips shall be constructed on all mainline roadway outside shoulders and on all median shoulders that are 5 feet or greater in width. Placement of rumble strips along mainline roadways shall be limited as follows:

   a. On approach to mainline toll plazas, the rumble strips shall terminate at the end of the mainline normal section.

   b. At entrance ramp terminals, rumble strips on outside shoulders shall terminate at the point of the physical gore and resume at the end of the acceleration lane taper.

   c. At exit ramp terminals, rumble strips on outside shoulders shall terminate at the start of the deceleration lane taper and resume at the point of the physical gore.

   d. On approach to bridges, the rumble strips shall terminate at the abutment joint.

   e. For rumble strip limitations at U-Turns and Z-Turns, refer to Section 1A.5.3 and Section 1A.5.4, respectively.

   f. Rumble strips may be eliminated at other locations at the direction of the Authority's Engineering Department.

3. Median Treatment

   a. The median type to be used shall be dictated by the overall design considerations of a specific situation. The various median types are shown on Exhibit 1A - 17 to Exhibit 1A - 19. Medians other than the standards shown shall require approval from the Authority's Engineering Department.

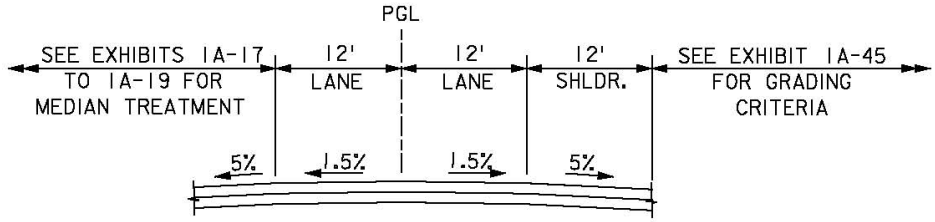
   b. The standard centerline median width (edge of travel way to edge of travel way) shall be 26 feet. The absolute minimum width shall be 13 feet or 7 feet, depending on the specific situation, to match the existing roadway section design.

   c. The standard inner-outer median width (edge of travel way to edge of travel way) shall be 26 feet. Where the outer roadway is 4 lanes, the standard width shall be 33 feet between same direction roadways. The absolute minimum width shall be 20 feet or 15 feet, depending on the specific situation, to match the existing roadway section design.

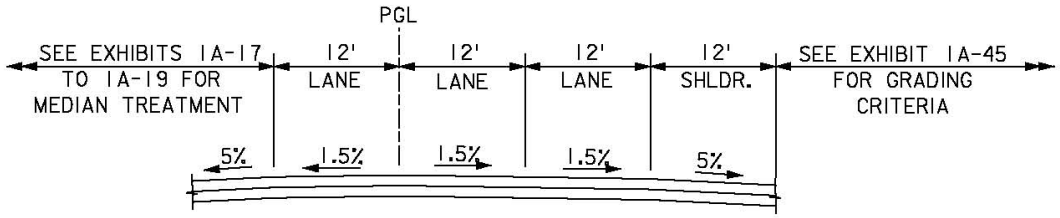
4. Lateral Bridge Clearances
   For mainline roadways, clearances shall be provided as shown on Exhibit 1A **-** 20.

5. For deviations to left shoulder widths on approach roadways to structures, refer to Section 2.2.1.3. Shoulder width shall be tapered at a rate of 1:100.

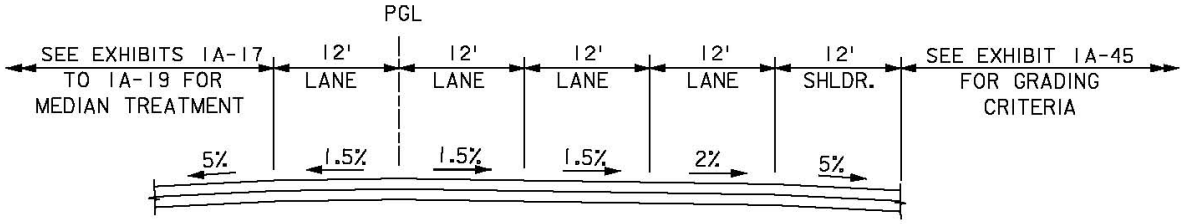
EXHIBIT 1A - 15
MAINLINE ROADWAY TYPICAL SECTIONS (NORMAL SECTIONS)



TWO LANE TRAVELWAY SECTION



THREE LANE TRAVELWAY SECTION

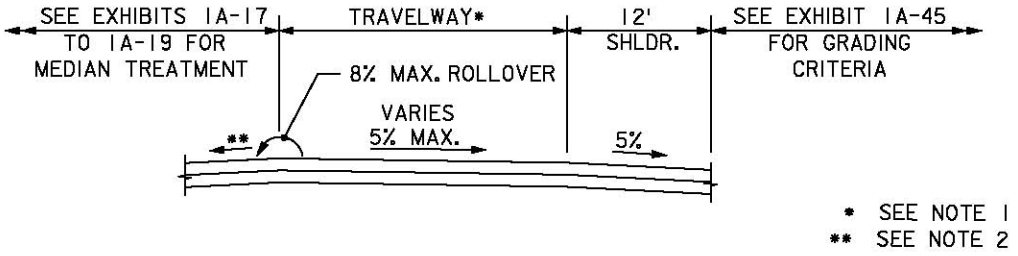


FOUR LANE TRAVELWAY SECTION

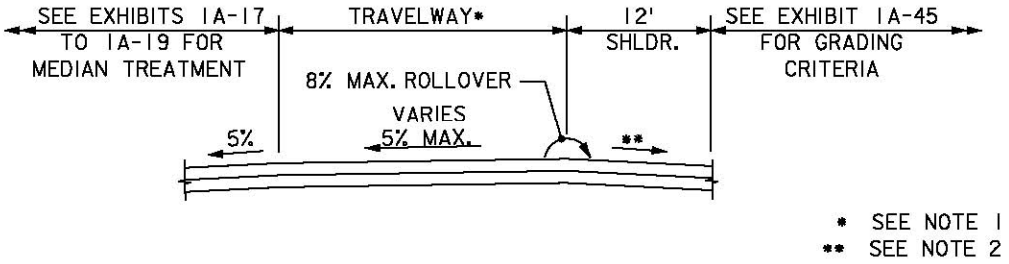
NOTES:

1. ROADWAY CROSS SLOPES SHALL BE ADJUSTED AS NEEDED AS PER SECTION 1A.2.5.
2. ABSOLUTE MINIMUM SHOULDER WIDTH SHALL BE 10 FEET.

EXHIBIT 1A - 16
MAINLINE ROADWAY TYPICAL SECTIONS (SUPERELEVATED SECTIONS)



SUPERELEVATED SECTION - CURVE RIGHT



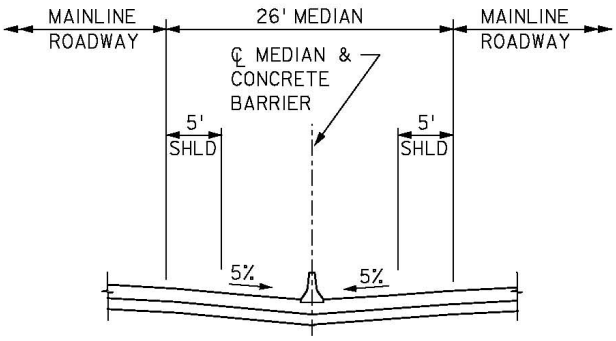
SUPERELEVATED SECTION - CURVE LEFT

NOTES:

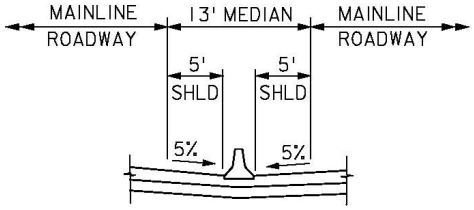
1. LANE WIDTHS AND PGL LOCATION ARE THE SAME AS SHOWN FOR THE NORMAL SECTIONS IN EXHIBIT 1A-15.

2. FOR SUPERELEVATED CROSS SLOPE $\leq$ 3%, THE SHOULDER CROSS SLOPE SHALL BE 5% MAXIMUM. FOR SUPERELEVATED CROSS SLOPE > 3% TO 5% MAXIMUM, THE SHOULDER CROSS SLOPE SHALL VARY FROM 5% MAXIMUM TO 3% MINIMUM. ROLLOVER FROM THE ADJACENT LANE TO SHOULDER SHALL NOT EXCEED 8% MAXIMUM.

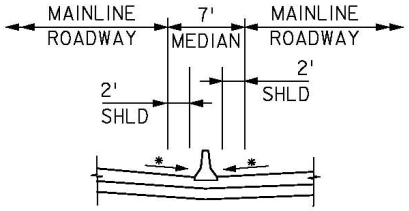
EXHIBIT 1A - 17
CENTER MEDIAN TYPICAL SECTIONS



STANDARD



DESIRABLE
MINIMUM



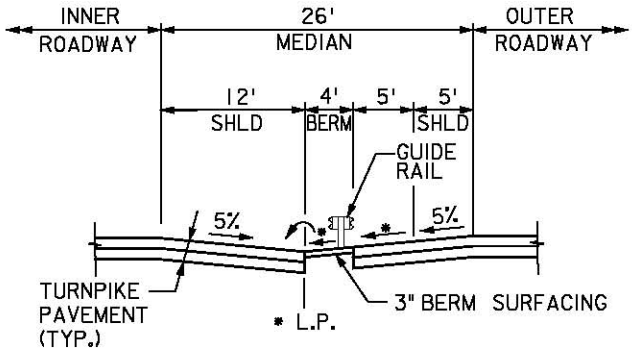
ABSOLUTE
MINIMUM

* SEE NOTE 2

NOTES:

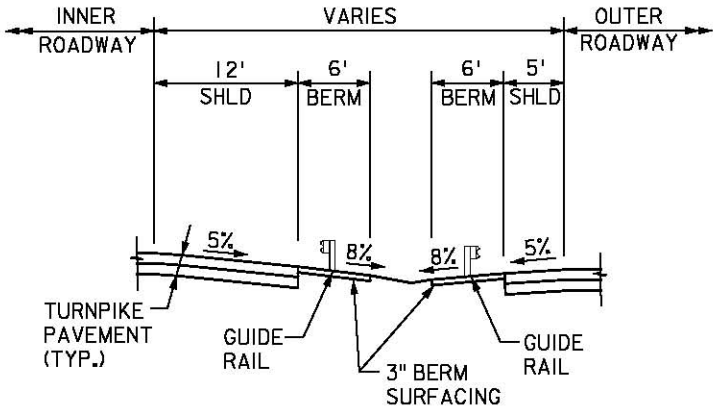
1. TURNPIKE PAVEMENT SHALL BE USED ACROSS ENTIRE CENTER MEDIAN.
2. MATCH ADJACENT LANE CROSS SLOPE, MIN. 1.5%.
3. NORMAL SHOULDER CROSS SLOPE = 5%. SEE EXHIBIT 1A-16 FOR CROSS SLOPE ADJUSTMENTS IN SUPERELEVATED SECTIONS.
4. SEE STANDARD DRAWINGS FOR UNDERDRAIN DETAILS.

EXHIBIT 1A - 18
INNER-OUTER MEDIAN TYPICAL SECTIONS (10 - 12 LANES)



* SEE NOTE 3

STANDARD



WIDE MEDIAN

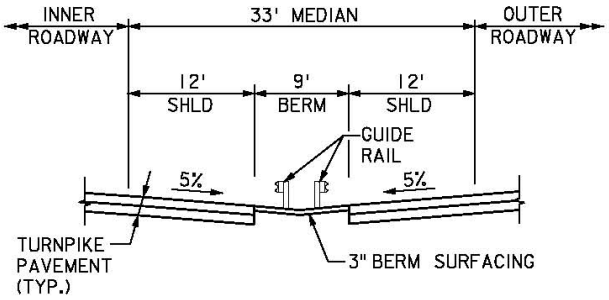
NOTES:

1. DUAL FACE GUIDE RAIL SHALL BE SET AT AN APPROPRIATE HEIGHT TO PROVIDE EFFECTIVENESS OF BEAM FROM BOTH ROADWAYS.

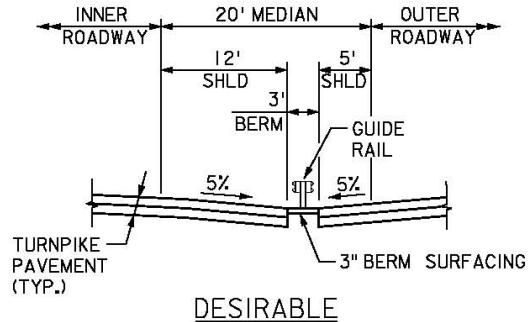
2. NORMAL SHOULDER CROSS SLOPE = 5%. SEE EXHIBIT 1A-16 FOR CROSS SLOPE ADJUSTMENTS IN SUPERELEVATED SECTIONS.

3. CROSS SLOPE = 5%. MAXIMUM CROSS SLOPE = 10% AS NEEDED TO MEET THE GRADE OF THE INNER ROADWAY. THE MEDIAN AREA BETWEEN SHOULDERS SHALL BE GRADED TO LOCATE THE LOW POINT OF THE SECTION AT THE BACK OF THE INNER ROADWAY SHOULDER AND 2' OFFSET FROM THE FACE OF GUIDE RAIL AS SHOWN.

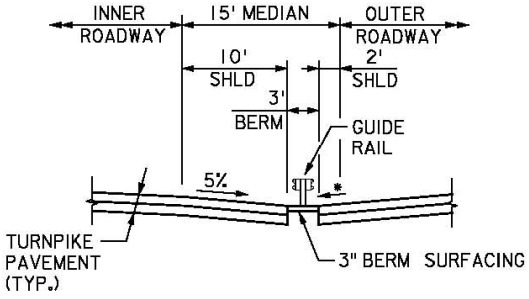
EXHIBIT 1A - 19
INNER-OUTER MEDIAN TYPICAL SECTIONS (14 LANES)



STANDARD



DESIRABLE MINIMUM



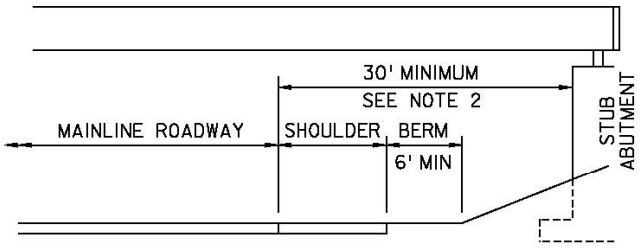
* SEE NOTE 4

ABSOLUTE MINIMUM

NOTES:

1. DUAL FACE GUIDE RAIL SHALL BE SET AT AN APPROPRIATE HEIGHT TO PROVIDE EFFECTIVENESS OF BEAM FROM BOTH ROADWAYS.
2. NORMAL SHOULDER CROSS SLOPE = 5%. SEE EXHIBIT 1A-16 FOR CROSS SLOPE ADJUSTMENTS IN SUPERELEVATED SECTIONS.
3. FOR UNDERDRAIN DETAILS, REFER TO THE STANDARD DRAWINGS.
4. MATCH ADJACENT LANE CROSS SLOPE, MIN. 1.5%.

EXHIBIT 1A - 20
LATERAL BRIDGE CLEARANCES - MAINLINE



TURNPIKE UNDERPASS

NOTES:

1. PIERS LOCATED IN THE CENTER MEDIAN OF THE TURNPIKE MAINLINE SHALL BE PLACED AT THE CENTERLINE OF THE MEDIAN. FOR PIERS LOCATED WITHIN THE INNER / OUTER MEDIAN OF DUALIZED ROADWAYS, THE PIER SHALL BE PLACED SUCH THAT THE MINIMUM SHOULDER DIMENSIONS AS SHOWN IN EXHIBITS 1A-18 AND 1A-19 FOR BOTH INNER AND OUTER ROADWAYS ARE MAINTAINED AT ALL TIMES.
2. PROVISION FOR ADDITIONAL LANES SHOULD BE CONSIDERED WHEN DETERMINING THE PIER OR ABUTMENT LOCATION ALONG THE OUTSIDE OF THE TURNPIKE MAINLINE.
3. ROADSIDE PROTECTION OF PIERS AND ABUTMENTS SHALL BE DESIGNED IN ACCORDANCE WITH SECTION 3.2.3.3 (GUIDE RAIL PROTECTION) AND SECTION 3.2.7 (CONCRETE BARRIER CURB PROTECTION) OF THIS MANUAL.

1A.2.9 Detours

1. The minimum design speed shall be 5 mph over regulatory speed limit with no reduction in the posted speed limit. Absolute minimum reduction in design speed shall be 10 mph.

2. Horizontal Alignment

   a. Desirable minimum radius curve shall be 3,000 feet. Absolute minimum radius curve shall be 1,800 feet. When back to back reverse curves are necessary, a sufficient tangent distance to effect the superelevation transitions is to be provided.

   b. Superelevation rates and transition lengths are to be consistent with the horizontal alignment and shall be reviewed on a case by case basis with the objective of attaining the smoothest ride possible.

3. Vertical Alignment
   Maximum profile grade shall be 3 percent. Minimum profile grade shall be sufficient to keep pavement free of ponding water.

4. Detour pavement shall be the same as mainline pavement. Any use of a substandard pavement section for a short period of time is subject to Authority's Engineering Department approval.

5. Typical detour section shall consist of normal 12-foot lanes and normal left and right shoulders throughout. Variations to this shall be treated with standard maintenance and protection of traffic practices.

6. Clearances shall be the same as for mainline roadways and interchange ramps. Refer to Subsection 1A.1.1.

7. Refer to Section 9 of this manual for detour signing.

8. All detours must be striped as if they were a permanent roadway. Where necessary, temporary pavement stripes may be used.

9. Temporary construction measures necessary for the protection of the environment (e.g. area of construction detours or temporary stream crossings) shall be adequately shown on plans and permits, and the payment therefore covered in the plans and specifications.

1A.3 INTERCHANGE RAMPS

1A.3.1 Roadway Designation

Ramps shall be designated such that the origin and then the destination of that roadway are given in order (i.e. from the toll plaza to the north – TN Ramp or from the north inner roadway to the toll plaza – NIT). See Subsection 1.4.1 of the Procedures Manual for a complete listing.

1A.3.2 Design Speed

The design speed for interchange ramps shall vary from 25 mph minimum to 50 mph maximum, with 40 mph desirable minimum for intermediate portions of long ramps. The central radius of the ramp shall be used for design speed control. Refer to Exhibit 1A - 21.

EXHIBIT 1A - 21
MINIMUM CURVE RADII FOR RAMP DESIGN SPEED

Ramp Central Radius in Feet for Maximum Superelevation (E_{max}=6%)	Recommended Design Speed (mph)
150	25
235	30
340	35
485	40
650	45
840	50

1A.3.3 Stopping Sight Distance

The minimum stopping sight distance for the various interchange ramp design speeds shall be as shown in Exhibit 1A - 22.

EXHIBIT 1A - 22
MINIMUM STOPPING SIGHT DISTANCE FOR INTERCHANGE RAMPS

Design Speed (mph)	Minimum Stopping Sight Distance (ft)
25	155
30	200
35	250
40	305
45	360
50	425

1A.3.4 Horizontal Alignment

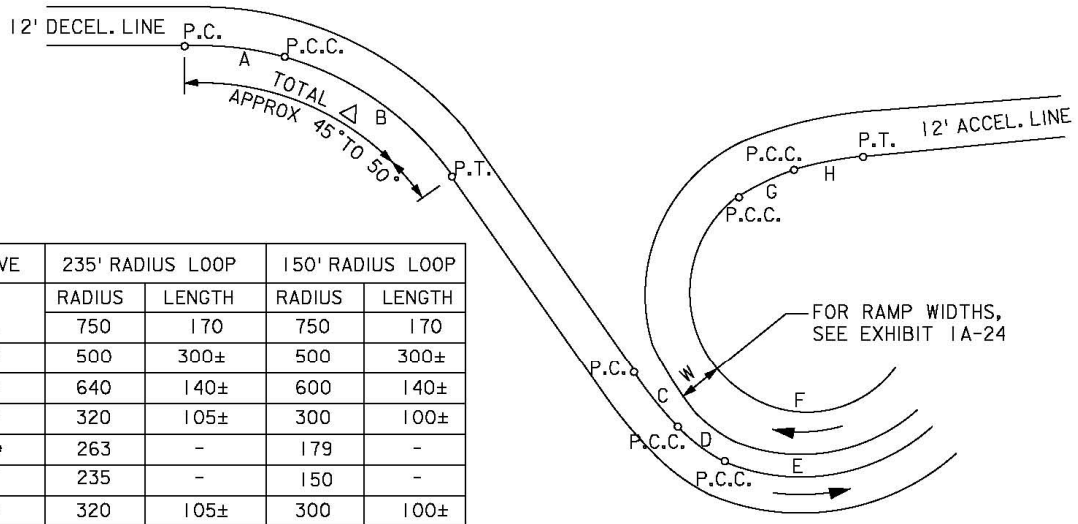
1. Radii
   The desirable minimum radius shall be 235 feet. The absolute minimum radius shall be 150 feet (waiver required from Chief Engineer). It is desirable to use as large a radius as project conditions will allow.

2. Ramp configuration and transition curves shall be as indicated on Exhibit 1A - 23.

3. The minimum lengths of curves shall be as indicated on Exhibit 1A - 23.

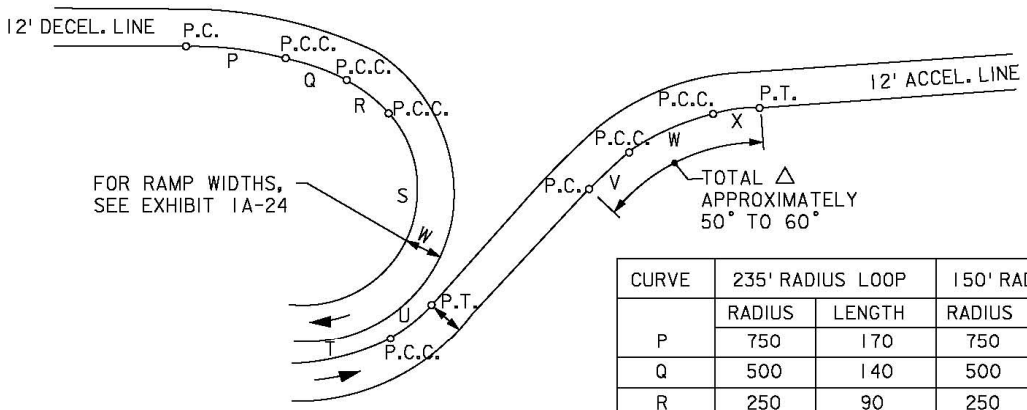
4. The minimum length of tangent between reverse curves shall be sufficient to accommodate the superelevation transitions between the reversing curves.

EXHIBIT 1A - 23
INTERCHANGE RAMP GEOMETRY



CURVE	235' RADIUS LOOP		150' RADIUS LOOP	
	RADIUS	LENGTH	RADIUS	LENGTH
A	750	170	750	170
B	500	300±	500	300±
C	640	140±	600	140±
D	320	105±	300	100±
E*	263	-	179	-
F	235	-	150	-
G	320	105±	300	100±
H	640	140±	600	140±

TURNOUTS TO AND FROM ENTRANCE LOOP



CURVE	235' RADIUS LOOP		150' RADIUS LOOP	
	RADIUS	LENGTH	RADIUS	LENGTH
P	750	170	750	170
Q	500	140	500	140
R	250	90	250	90
S	235	-	150	-
T*	263	-	179	-
U	350±	110±	300±	100+
V	640±	140±	640	140±
W	320±	200±	320	200±
X	640	140±	640	140±

* INCREASE RADII AS NECESSARY FOR TWO LANE INNER LOOP RAMP.

TURNOUTS TO AND FROM EXIT LOOP

5. Ramp lane width shall vary with horizontal radii as per Exhibit 1A - 24.

6. In the area of horizontal transition curves, it is intended that smooth lane width transitions, controlled by the central radius, be used.

7. For typical acceleration and deceleration lane treatment, see Subsection 1A.4.

EXHIBIT 1A - 24
MINIMUM INTERCHANGE RAMP LANE WIDTH BY RADII

Radius at Lane Edge of Inside Curve	Lane Width for One Lane Ramp		Width of Two Lane Ramp
	Des. Min.	Abs. Min.	
150’	22’	18’	33’
200’	20’	17’	30’
235’	20’	16.5’	30’
250’	19’	16’	28.5’
300’	18’	15.5	27’
400’	18’	15’	26’
500’	18’	15’	26’
Tangent	12’	12’	24’

1A.3.5 Superelevation

1. Interchange ramp superelevation rates shall be determined from Exhibit 1A - 25 based on a maximum superelevation rate of 6%.

   a. For a ramp profile grades less than 0.5 percent, the minimum ramp cross slope is to be increased from 1.5 to 2 percent. When the section is curbed, the shoulder cross slope is transitioned between 2 and 5 percent to control drainage flow along the curb.

   b. If a design assignment involves modification or resurfacing of an existing interchange ramp, the rate of superelevation to be used shall normally follow the current standard, as described in this section. However, if a bridge deck falls within the horizontal curve and the deck superelevation is not being upgraded, the rate of superelevation for the entire length of the horizontal curve shall not exceed that on the existing bridge deck.

EXHIBIT 1A - 25
MINIMUM INTERCHANGE RAMP RADII FOR DESIGN SUPERELEVATION RATES, E_{MAX}= 6%

e_d (%)	V_d= 25 mph R(ft)	V_d= 30 mph R(ft)	V_d= 35 mph R(ft)	V_d= 40 mph R(ft)	V_d= 45 mph R(ft)	V_d= 50 mph R(ft)
1.5	2290	3130	4100	5230	6480	7870
2.0	1630	2240	2950	3770	4680	5700
2.2	1450	2000	2630	3370	4190	5100
2.4	1300	1790	2360	3030	3770	4600
2.6	1170	1610	2130	2740	3420	4170
2.8	1050	1460	1930	2490	3110	3800
3.0	944	1320	1760	2270	2840	3480
3.2	850	1200	1600	2080	2600	3200
3.4	761	1080	1460	1900	2390	2940
3.6	673	972	1320	1740	2190	2710
3.8	583	864	1190	1590	2010	2490
4.0	511	766	1070	1440	1840	2300
4.2	452	684	960	1310	1680	2110
4.4	402	615	868	1190	1540	1940
4.6	360	555	788	1090	1410	1780
4.8	324	502	718	995	1300	1640
5.0	292	456	654	911	1190	1510
5.2	264	413	595	833	1090	1390
5.4	237	373	540	759	995	1280
5.6	212	335	487	687	903	1160
5.8	186	296	431	611	806	1040
6.0	150	235	340	485	650	840

2. Tangent to Curve Transition

   a. Ramp superelevation shall be controlled by the central radius of the ramp. Full superelevation as indicated by the central radius of a ramp shall not be attained before that radius is reached. A smooth superelevation transition shall be provided over the length of the corresponding horizontal transition.

   b. The minimum length of superelevation runoff on interchange ramps shall be determined from the same methods used on mainline roadways. See Subsection 1A.2.5. The values for maximum relative gradient shall be determined from Exhibit 1A - 26 for the various interchange ramp design speeds.

   c. The minimum tangent runout length required to remove adverse crown on interchange ramps shall be determined from the same methods used on mainline roadways. See Subsection 1A.2.5.

d. The location of the superelevation runoff length with respect of the point of curvature (PC) shall be as shown in Exhibit 1A - 27.

EXHIBIT 1A - 26
MAXIMUM RELATIVE GRADIENT (INTERCHANGE RAMP)

Design Speed (mph)	Maximum Relative Gradient %
25	0.70
30	0.66
35	0.62
40	0.58
45	0.54
50	0.50

EXHIBIT 1A - 27
LOCATION OF SUPERELEVATION RUNOFF (INTERCHANGE RAMPS)

Design Speed (mph)	Portion of Runoff Located Prior to the Curve			
	No. of Lanes Rotated			
	1.0	1.5	2.0 – 2.5	3.0 – 3.5
25 – 45	0.80	0.85	0.90	0.90
50	0.70	0.75	0.80	0.85

If the specific values listed above are not attainable for a given location, then the portion of superelevation runoff prior to the PC shall fall within the range of 0.60 to 0.90.

1A.3.6 Vertical Alignment

1. Grades

   a. Desirable maximum profile upgrade shall be 5 percent. Absolute maximum profile upgrade shall be 7 percent.

   b. Maximum profile downgrade shall be 5 percent.

   c. Desirable minimum profile grade shall be 0.5 percent. Absolute minimum profile grade shall be 0.3 percent. See Subsection 1A.3.5 for ramp superelevation with less than 0.5 percent profile grade.

   d. Short tangents (less than 100 ft) between vertical curves should be avoided if possible. In this case, it is preferable for the location of the PVT and PVC of successive curves to coincide.

2. Vertical Curves

   a. The minimum length of vertical curve shall be determined from the same methods used on mainline roadways. See Subsection 1A.2.6. The minimum value of K shall be determined from Exhibit 1A - 28 for the various interchange ramp design speeds.

   b. The PVI (point of vertical intersection of two grades) station shall be located at an even 25-foot station increment where feasible.

   c. For an "A" less than or equal to 0.25 percent, an angle point shall be established, and no vertical curve used.

EXHIBIT 1A - 28
DESIGN CONTROLS FOR INTERCHANGE RAMP VERTICAL CURVES

Design Speed (mph)	Stopping Sight Distance (ft)	Crest K	Sag K
	Minimum		
25	155	20	30
30	200	30	40
35	250	47	50
40	305	70	64
45	360	98	79
50	425	136	96

1A.3.7 Pavement

The interchange ramp pavement section shall be similar to the mainline section. See Subsection 1A.2.7.

1A.3.8 Typical Section

1. For typical interchange ramp dimensions and cross slopes for normal and superelevated sections, see Exhibit 1A - 29.

2. Rumble Strips shall not be constructed on interchange ramps. Refer to Section 1A.2.8 for the limits of rumble strip construction at interchange areas.

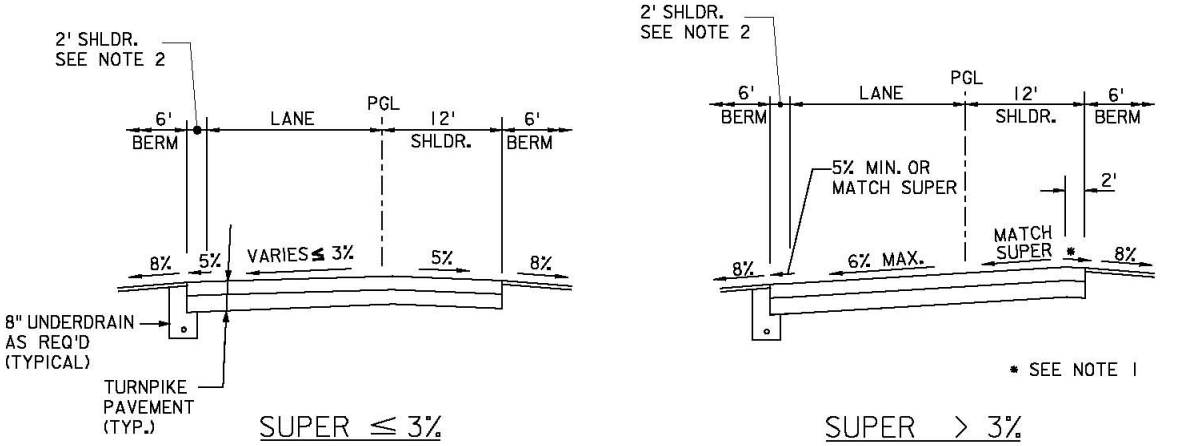
3. Median treatment between ramps is shown on Exhibit 1A - 30.

4. For placement of asphalt lip curb with guide rail, see Section 3.2.6.11.

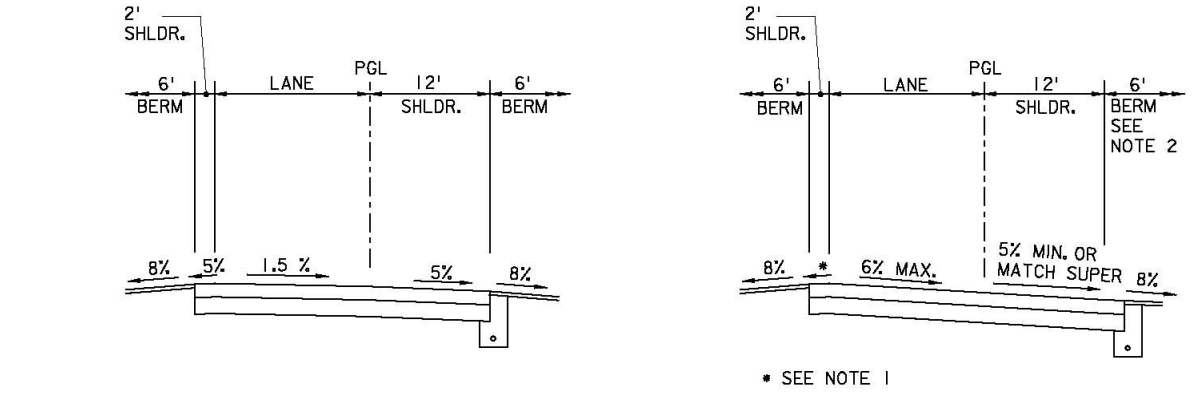
5. Concrete curb shall be used on the inside edge of shoulder on ramps with a radius of 250 feet or less, except when guide rail and lip curb are used.

6. Lateral Bridge Clearances
   For ramps, clearances shall be provided as shown on Exhibit 1A - 31.

EXHIBIT 1A - 29
INTERCHANGE RAMP TYPICAL SECTIONS



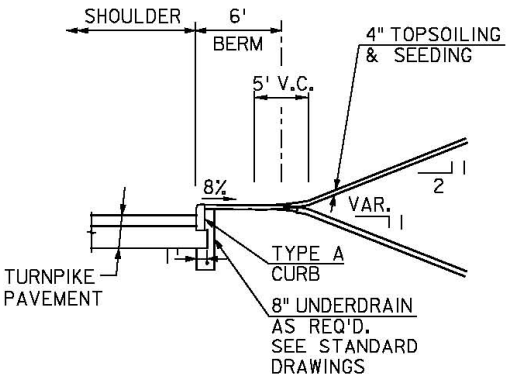
ONE-WAY RAMP - CURVE LEFT



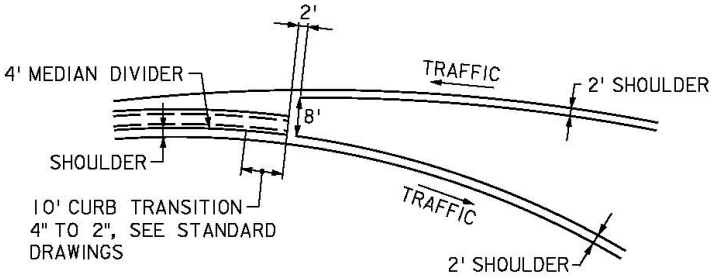
NOTES:

1. FOR SUPERELEVATED ROADWAY CROSS SLOPE ≤3%, SHOULDER CROSS SLOPE = 5%. FOR SUPERELEVATED ROADWAY CROSS SLOPE >3% TO 6% MAXIMUM, SHOULDER CROSS SLOPE SHALL VARY FROM <5% MAXIMUM TO 2% MINIMUM. (i.e. 8% MAXIMUM ROLLOVER).
2. CONCRETE CURB SHOULD BE USED ON INSIDE EDGE OF RAMPS WITH RADIUS ≤250', EXCEPT WHEN GUIDE RAIL AND LIP CURB ARE USED.
3. WIDEN, IF REQUIRED, FOR HORIZONTAL SIGHT DISTANCE AS NEEDED.
4. BERM AND GRADING CRITERIA FOR RAMPS SHALL BE SIMILAR TO THE MAINLINE AS SHOWN ON EXHIBIT 1A-30 AND 1A-45.

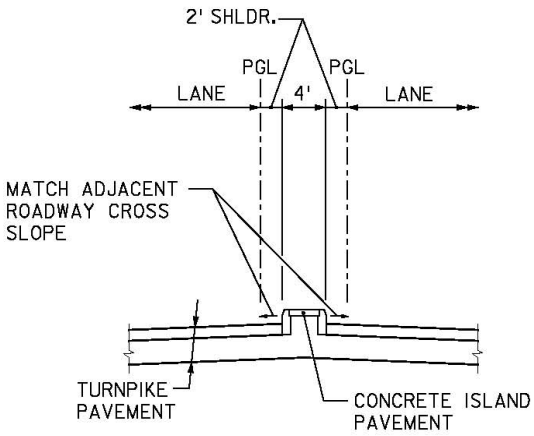
EXHIBIT 1A - 30
INTERCHANGE RAMP CURB SECTIONS AND DETAILS



TYPICAL CURB SECTION

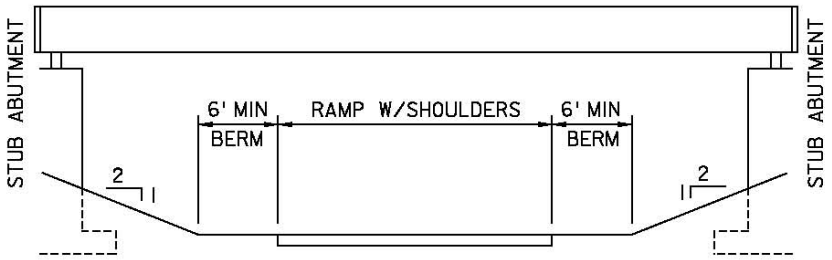


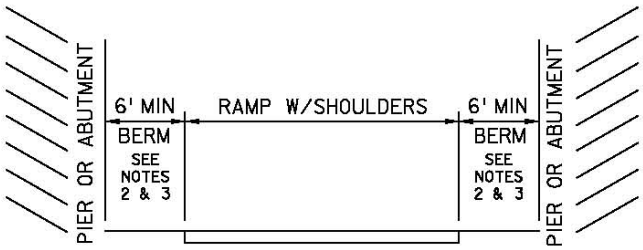
TWO-WAY RAMP CURB TRANSITION



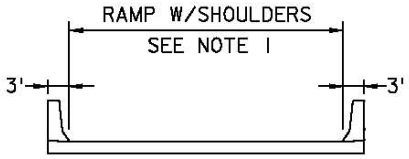
TWO-WAY RAMP DIVIDER

EXHIBIT 1A - 31
LATERAL BRIDGE CLEARANCES - RAMPS





RAMP UNDERPASS



RAMP OVERPASS

NOTES:

1. RAMP SHOULDER WIDTH ON STRUCTURE TO BE WIDENED AS NEEDED TO PROVIDE MINIMUM STOPPING SIGHT DISTANCES AS PER EXHIBIT 1A-22.
2. STOPPING SIGHT DISTANCE ON HORIZONTAL CURVES GOVERNS OFFSET TO PIER OR ABUTMENT (SEE EXHIBIT 1A-22).
3. ROADSIDE PROTECTION OF PIERS AND ABUTMENTS SHALL BE DESIGNED IN ACCORDANCE WITH SECTION 3.2.3.3 (GUIDE RAIL PROTECTION) AND SECTION 3.2.7 (CONCRETE BARRIER CURB PROTECTION) OF THIS MANUAL.

1A.3.9 Detours

1. The design speed shall be 25 mph minimum.

2. Horizontal Alignment

   a. Minimum radius curve shall be 150 feet.

   b. Superelevation rates and transition lengths are to be consistent with the horizontal alignment and shall be reviewed on a case-by-case basis with objective of attaining the smoothest ride possible.

3. Vertical Alignment
   Maximum profile grade shall be 7 percent. Minimum profile grade shall be sufficient to keep pavement free of ponding water.

4. Detour pavement shall be the same as mainline pavement. Any use of a substandard pavement section for a short period of time is subject to Authority's Engineering Department approval.

5. Typical detour section shall be similar to the normal ramp section. Variations to this shall be treated with standard maintenance and protection of traffic procedures.

6. Clearances shall be the same as for mainline roadways and interchange ramps. Refer to Subsection 1A.1.1.

7. Refer to Section 9 of this manual for detour signing on ramps.

8. All detours must be striped as if they were a permanent ramp. Where necessary, temporary pavement stripes may be used.

9. All ramp detours shall be lighted; see Section 7 of this manual.

10. Temporary construction measures necessary for the protection of the environment (e.g. area of construction detours or temporary stream crossings) shall be adequately shown on plans and permit applications, and the payment therefore covered in the plans and specifications.

1A.4 AUXILIARY LANES

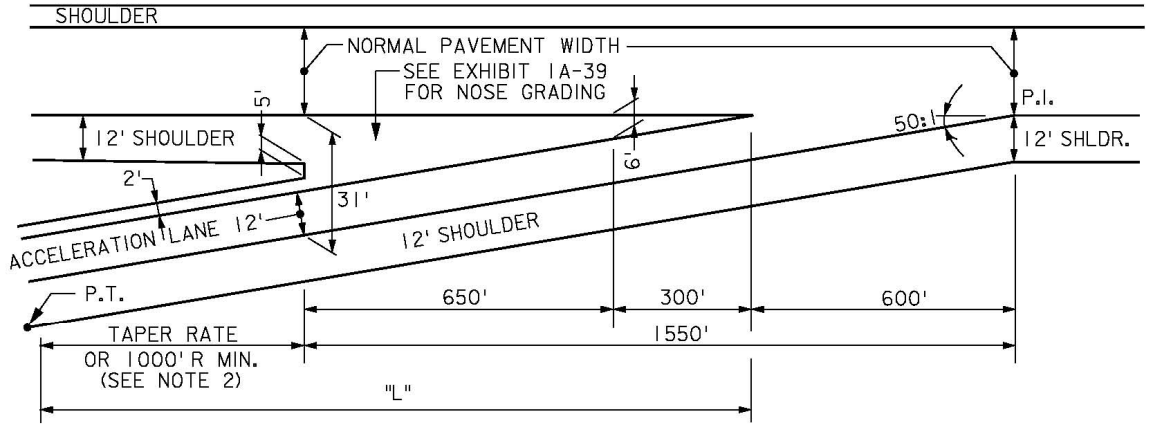
1A.4.1 Acceleration Lanes

A typical acceleration lane is shown in Exhibit 1A - 32.

1. Where the acceleration lane falls within a section of roadway with 3 percent or greater profile (upgrade or downgrade), the acceleration lengths from Exhibit 1A - 33 shall be adjusted by the ratios indicated in Exhibit 1A **-** 34 to determine minimum acceleration lane lengths.

2. It is intended that a two-lane entrance ramp shall consist of the typical ramp acceleration geometry as shown in Exhibit 1A - 32, followed by consecutive single lane drops totaling 2,400 feet to merge the ramp lanes into the mainline roadway. The continuity of the through (mainline) roadway shall be maintained at all times. A typical two-lane entrance ramp is shown in Exhibit 1A - 35. This application can be further extended to the merge of two major roadways, requiring a total minimum length of 3,600 feet for three consecutive lane drops with the roadway lanes on the left having mainline priority. In both instances, the minimum length shall be adjusted by the ratios in Exhibit 1A **-** 34 where the profile (upgrade or downgrade) is 3 percent or greater.

EXHIBIT 1A - 32
RAMP ACCELERATION LANE GEOMETRY



NOTES:

1. "L" SHALL BE OBTAINED FROM EXHIBITS 1A-33 AND 1A-34 FOR ACCELERATION LENGTH AND GRADE ADJUSTMENT FACTORS.
2. THE RATIO OF A FLATTER RADIUS TO A SHARPER RADIUS SHALL NOT EXCEED 2.
3. IF THE MAINLINE IS CURVED, THE ACCELERATION LANE SHALL BE CURVED TO FIT THE DIMENSIONS SHOWN.

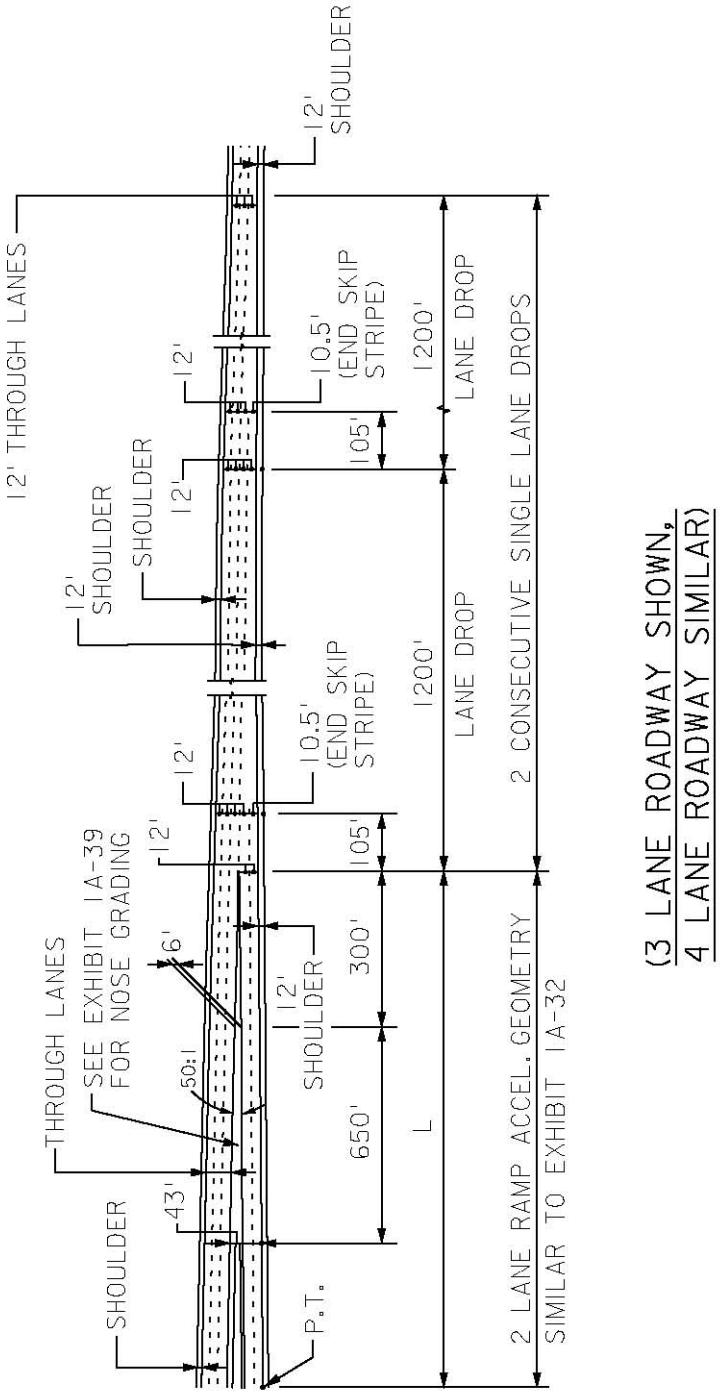
EXHIBIT 1A - 33
MINIMUM LENGTH OF ACCELERATION LANE

Highway Design Speed, *V* (mph)	Acceleration Length, *L* (ft) for Entrance Curve Design Speed (mph)					
	25	**30**	**35**	**40**	**45**	**50**
60	1020	910	800	550	420	180
70	1420	1350	1230	1000	820	580

EXHIBIT 1A - 34
ACCELERATION LANE GRADE ADJUSTMENT FACTORS

Highway Design Speed (mph)	Acceleration Lanes Ratio of Length on Grade to Length of Level for Design Speed of Turning Curve (mph)			
	30	**40**	**50**	**All Speeds**
	3 to 4% upgrade			3 to 4% downgrade
60	1.5	1.5	1.6	0.6
70	1.6	1.7	1.8	0.6
	5% upgrade			5% downgrade
60	1.9	2.2	2.5	0.5
70	2.2	2.6	3.0	0.5

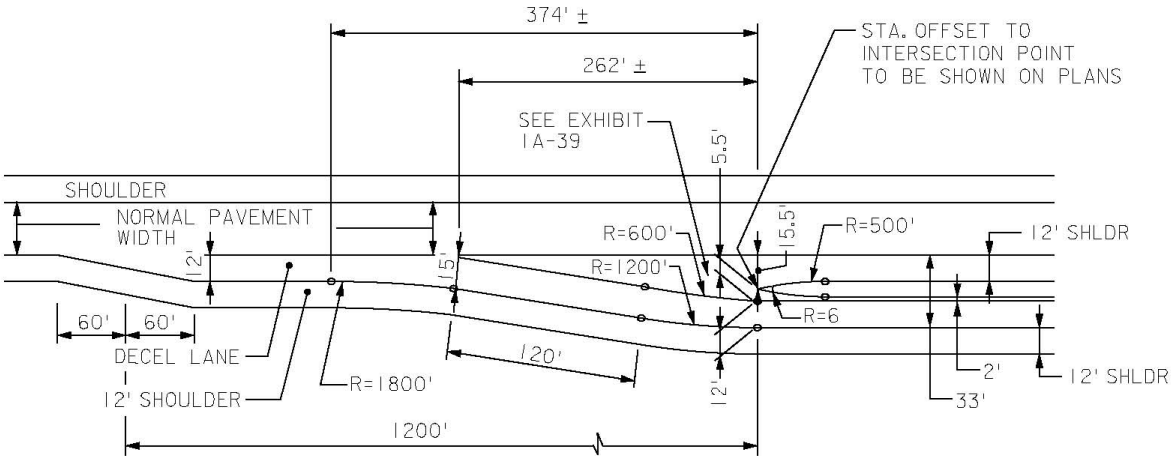
EXHIBIT 1A - 35
TWO-LANE ENTRANCE RAMP



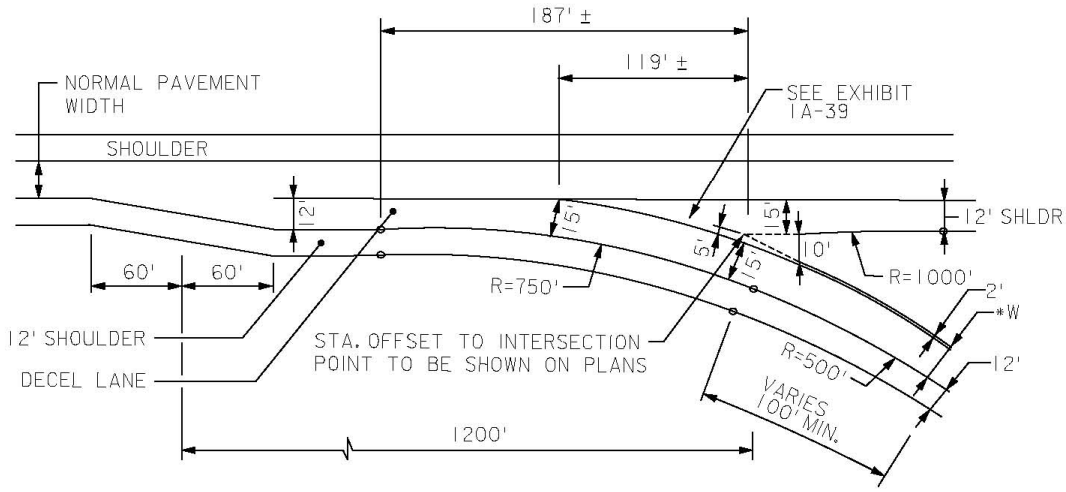
1A.4.2 Deceleration Lanes

Two types of deceleration lanes are shown on Exhibit 1A - 36. The application of these two types is dependent upon the overall geometry of the situation. The "Parallel Ramp Configuration" is generally used in conjunction with a dual-dual roadway.

EXHIBIT 1A - 36
RAMP DECELERATION LANE GEOMETRY



TYPICAL DECELERATION LANE FOR PARALLEL RAMP CONFIGURATION



TYPICAL DECELERATION LANE FOR LOOP RAMP CONFIGURATION

* SEE EXHIBIT 1A-24

1. The intent of a two-lane exit ramp is to provide successive deceleration lengths, thus requiring a total minimum length of 2,400 feet. A typical two-lane exit ramp is shown in Exhibit 1A - 37.

2. The treatment of a major split of three lanes into two roadways of three lanes each is different in concept from successive deceleration lanes. In this case a total minimum length of 3,600 feet from the beginning of the split to the nose is required, with each original lane (12 feet) expanding to two lanes (24 feet) simultaneously.

3. A typical lane drop configuration following a deceleration lane exit is shown on Exhibit 1A - 38.

EXHIBIT 1A - 37
TWO-LANE EXIT RAMP

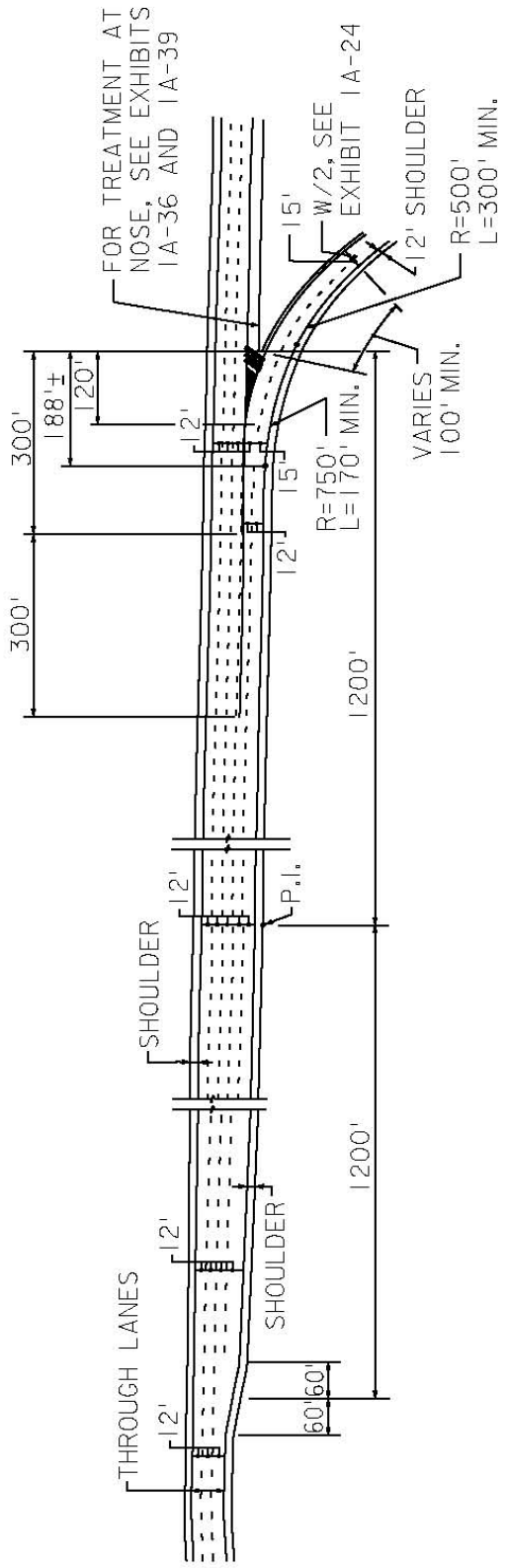
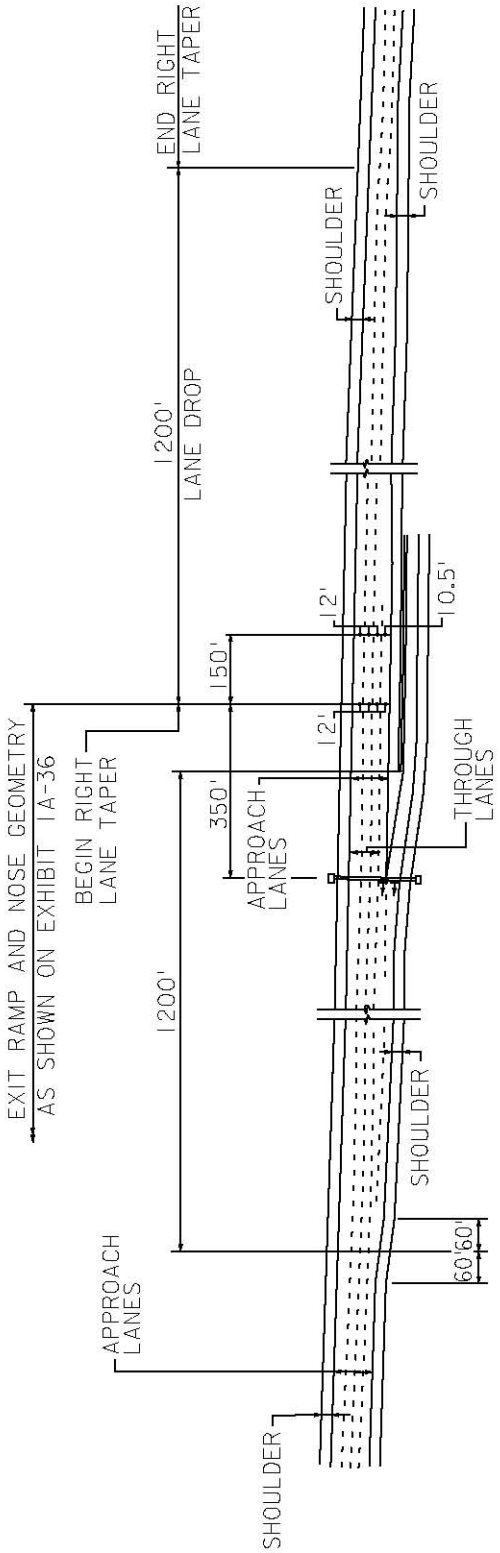


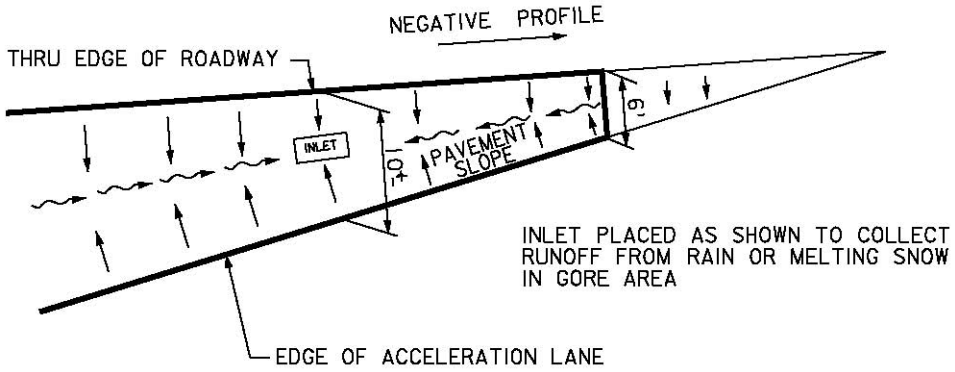
EXHIBIT 1A - 38
LANE DROP CONFIGURATION



(4 TO 3 LANE ROADWAY SHOWN, 3 TO 2 LANE ROADWAY SIMILAR)
(REFER TO SECTION 6A FOR SIGN LOCATIONS)

4. Typical nose grading between mainline roadway and auxiliary lanes is shown in Exhibit 1A - 39.

EXHIBIT 1A - 39
TYPICAL NOSE GRADING



1A.4.3 Climbing Lanes

With a maximum of 3 percent grades, the Authority does not use truck climbing lanes. As indicated in Subsection 1A.2.6, the absolute minimum length of vertical tangent shall be limited by a maximum permissible loss in truck speed of 10 mph.

1A.5 OTHER ROADWAYS

1A.5.1 Crossroads

Where local roads are being replaced, the intent of the Authority with respect to any work under the jurisdiction of the state, county, municipality, or any other agency is “replacement in kind”, according to the present standards of that agency. All such work is subject to the approval of the Authority’s Engineering Department and must be previously agreed to in writing by the concerned agency, as noted elsewhere in this manual ***and the Procedures Manual***.

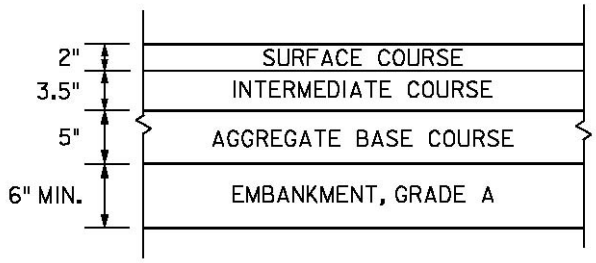
Similarly, all detouring and/or closing of local roads during construction must be ***approved by the appropriate agencies in accordance with the Procedures Manual.***

1A.5.2 Access and Service Roads

1. Treatment shall be similar to Subsection 1A.5.1.

2. For parking lots and driveways at toll plaza buildings and other locations within the Turnpike right of way, the pavement section shall be as shown on Exhibit 1A - 40. Refer to Subsection 1A.2.7 for additional information and details.

EXHIBIT 1A - 40
CAR PARKING PAVEMENT SECTION



NOTES:

1. TRUCK PARKING AREAS SHALL BE PAVED WITH TURNPIKE PAVEMENT, AS SHOWN IN EXHIBIT 1A-9.

1A.5.3 U-Turns

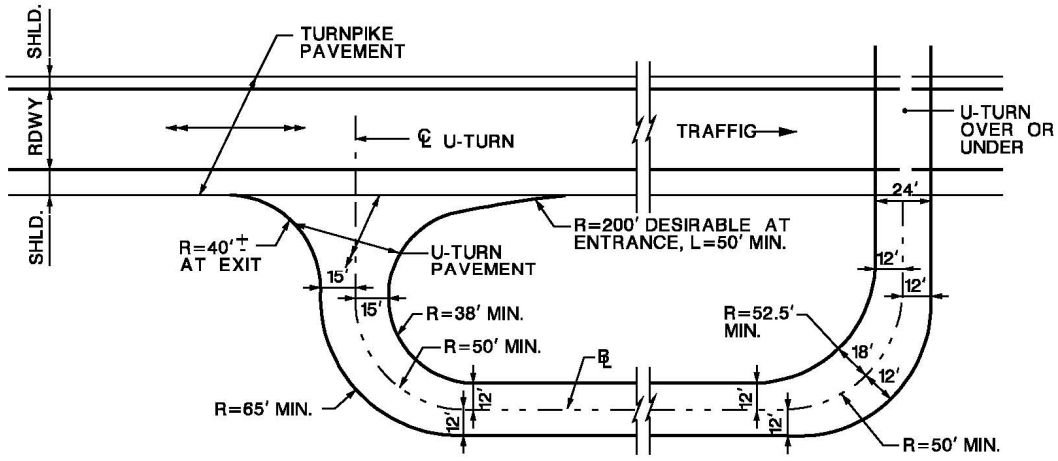
1. U-Turns shall be designated by milepost location. Refer to Section 6A for U-Turn signing.

2. Location
   a. Within one mile of and on each side of an interchange.
   b. No more than five miles apart between interchanges.

3. Configuration and Alignment
   a. All U-Turns shall be grade separated through the end span of a structure when the mainline passes over a crossroad etc., or on a separate overhead structure when necessary.
   b. Maximum profile grade shall be 5 percent.
   c. Rumble strips shall not be placed in the mainline shoulder within 300 feet on either side of the U-Turn entrance / exit.
   d. For all other information, see Exhibit 1A - 41 and Exhibit 1A - 43.

4. The pavement section for grade separated U-Turns shall be as shown on Exhibit 1A - 42. Refer to Section 1A.2.7 for additional information and details.

EXHIBIT 1A - 41
U-TURN GEOMETRIC CRITERIA



GRADE SEPARATED U-TURN NOTES:

1. CONDITIONS SHOWN ARE MINIMUM.
2. 5% MAXIMUM PROFILE GRADE.
3. U-TURN SHOULD BE WIDENED AS INDICATED FOR TIGHTER RADII.
4. SEE SECTION 6A OF THIS MANUAL FOR SIGNING.
5. LOCATE U-TURNS WITHIN ONE MILE OF AND ON EACH SIDE OF EVERY INTERCHANGE.

RAMP WIDENING

BASE LINE RADIUS	MID-CURVE RAMP WIDTH
50'	30'
100'	27'
200'	26'
>400'	24'

EXHIBIT 1A - 42
U-TURN PAVEMENT SECTION

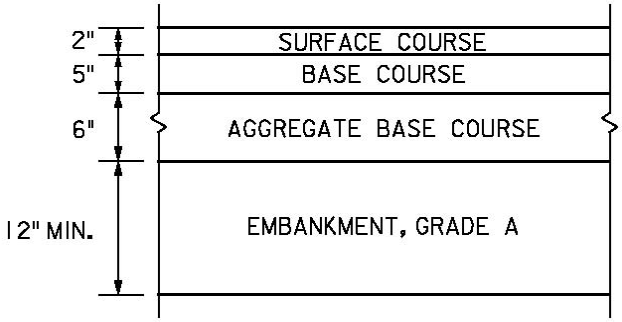
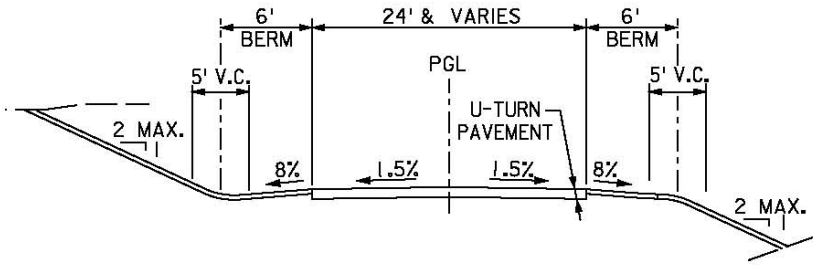
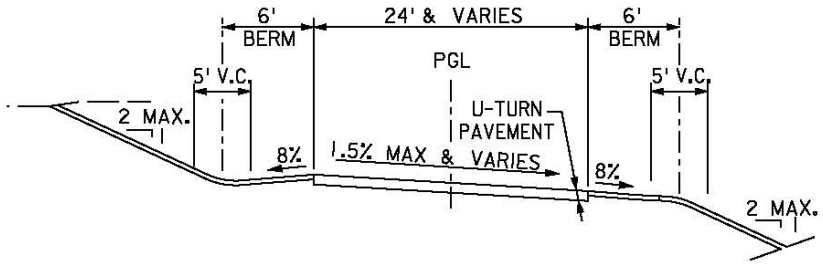


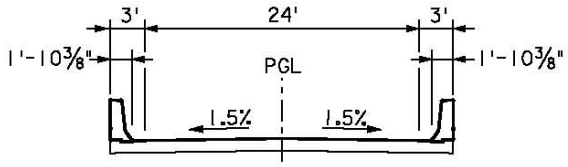
EXHIBIT 1A - 43
U-TURN TYPICAL SECTIONS



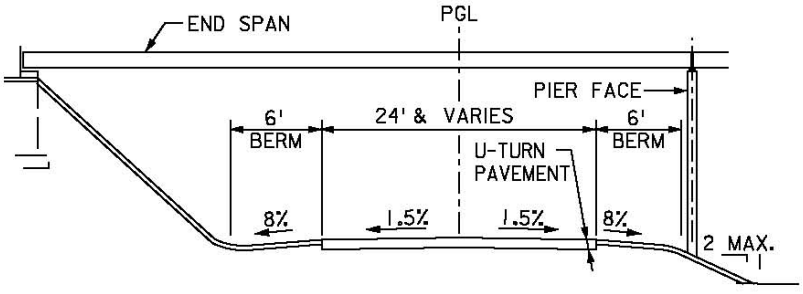
U-TURN NORMAL SECTION



U-TURN SUPERELEVATED SECTION



U-TURN STRUCTURAL SECTION



U-TURN SECTION UNDER STRUCTURE

NOTE:

1. SEE EXHIBIT 1A-41 FOR U-TURN GEOMETRY AND RAMP WIDENING.

1A.5.4 Z-Turns

1. Z-Turns shall be designated by milepost location.

2. Use and Location

   a. Z-Turns shall be used on dual-dual roadway between same direction roadways as a connection between those roadways.

   b. Z-Turns shall be used in conjunction with grade separated U-turns and shall be approximately 2,500 feet on each side of the U-Turns for 70 mph design speed and approximately 2,000 feet for 60 mph design speeds. The absolute minimum distance shall be 1,500 feet.

   c. Drainage within Z-Turn median shall be maintained.

   d. Refer to Section 6A for signing.

3. Configuration

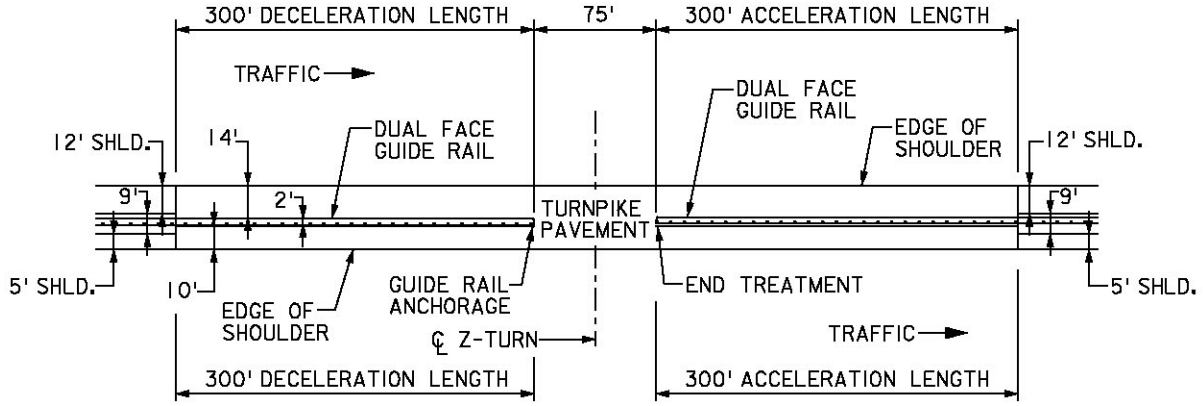
   a. Z-Turns shall be at-grade crossovers as shown on Exhibit 1A - 44.

   b. Rumble strips shall not be placed within 300 feet of the Z-Turn opening on either side of the median.

4. The pavement section for Z-Turns shall be Turnpike Pavement as shown on Exhibit 1A - 9

5. See Standard Drawings GR-14 and GR-15 for further details concerning Z-Turn configuration.

EXHIBIT 1A - 44
Z-TURN GEOMETRIC CRITERIA



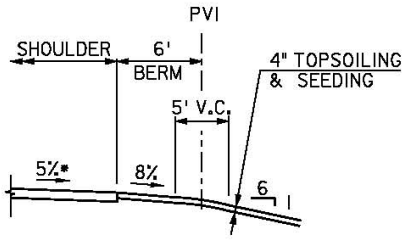
Z-TURN GEOMETRIC CRITERIA

1A.6 GRADING CRITERIA

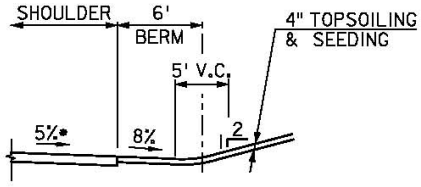
The general grading criteria set forth in this section are intended to be used as guidelines to achieve an economically feasible, safe and aesthetically pleasing design. Variations to the specified criteria are permissible as long as the design adequately complies with the intent of the guidelines. Variations in side slopes should be investigated in order to obtain a favorable earthwork balance. Every effort is to be made to limit the use of critical slopes where feasible so as to eliminate the need for guide rail. Consideration shall be given to the impact on right of way, earthwork, aesthetics, existing trees, utilities, regulated areas, etc.

1. Grading in Fill Areas
    a. Variable side slopes, depending on the height of fill at the PVI of berm, shall be used for all ramps and for existing Turnpike roadways. See Exhibit 1A - 45.
        i. 0 - 5 feet fills - 6:1 slope
        ii. 5-10 feet fills - 4:1 slope
        iii. 10 feet and greater fills - 2:1 slope maximum
    b. Refer to Section 3 (Guide Rail / Median Barrier / Attenuator Design) of this Manual for guide rail requirements related to height of fill. Safety grading criteria may be utilized on mainline roadways as directed by the Authority's Engineering Department in order to eliminate guide rail warrants.
    c. Mainline and ramp sections shall have a berm width of 6 feet minimum sloping away from the roadway at an 8 percent grade.
    d. All roundings shall have 5-foot vertical curves.
2. Grading in Cut Areas
    a. 2:1 maximum side slopes are recommended throughout. See Exhibit 1A - 45.
    b. Berm widths are the same as for fill sections.
    c. All roundings shall have 5-foot vertical curves.
    d. Cut sections in rock will be subject to Authority's Engineering Department approval of the Engineer's soils recommendations.
    e. In borrow projects, the Engineer shall investigate the possibility of using flatter cut slopes in an attempt to achieve a more favorable earthwork balance.

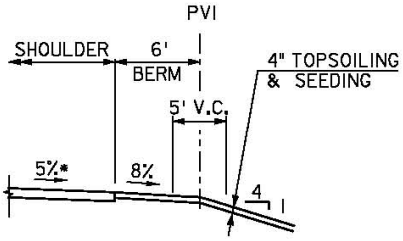
EXHIBIT 1A - 45
TURNPIKE GRADING CRITERIA



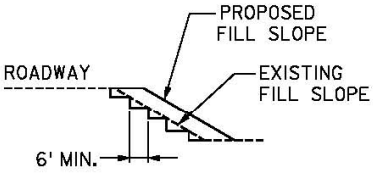
FILLS LESS THAN 5'



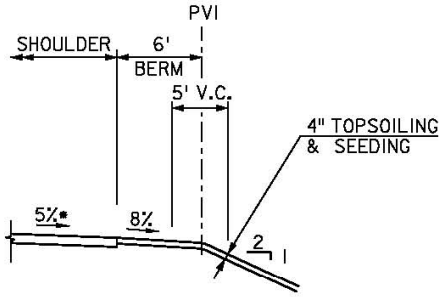
TYPICAL CUT SECTION



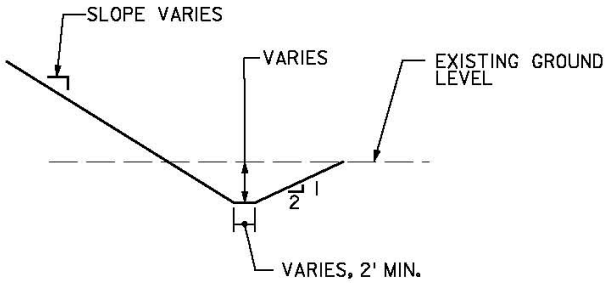
FILLS 5' TO 10'



BENCHING DETAIL



FILLS GREATER THAN 10'
(SEE NOTE #3)



TOE OF SLOPE DITCH

NOTES:

1. HEIGHT OF FILL IS MEASURED FROM PVI OF BERM.

*2. NORMAL SHOULDER CROSS SLOPE IS 5%. SEE MAINLINE AND RAMP TYPICAL SECTIONS FOR CROSS SLOPE ADJUSTMENT IN SUPERELEVATED SECTIONS.

3. REFER TO SECTION 3 OF THIS MANUAL FOR GUIDE RAIL WARRANTS AND PLACEMENT.

1A.7 FENCING

1. General
   The policy of the Authority is to fence all Turnpike right of way.

2. Usage

   a. Chain Link fence shall be used around interchanges, service areas and maintenance areas; along the right of way adjacent to existing commercial or residential areas or areas zoned for future commercial or residential development and 1,000 feet either side of the limits of these areas; along local roads and 500 feet either side of local roads along the Authority's right of way; and at all other locations at the direction of the Authority's Engineering Department.

   b. Chain link fence shall be as per the Standard Drawings.

3. Configuration

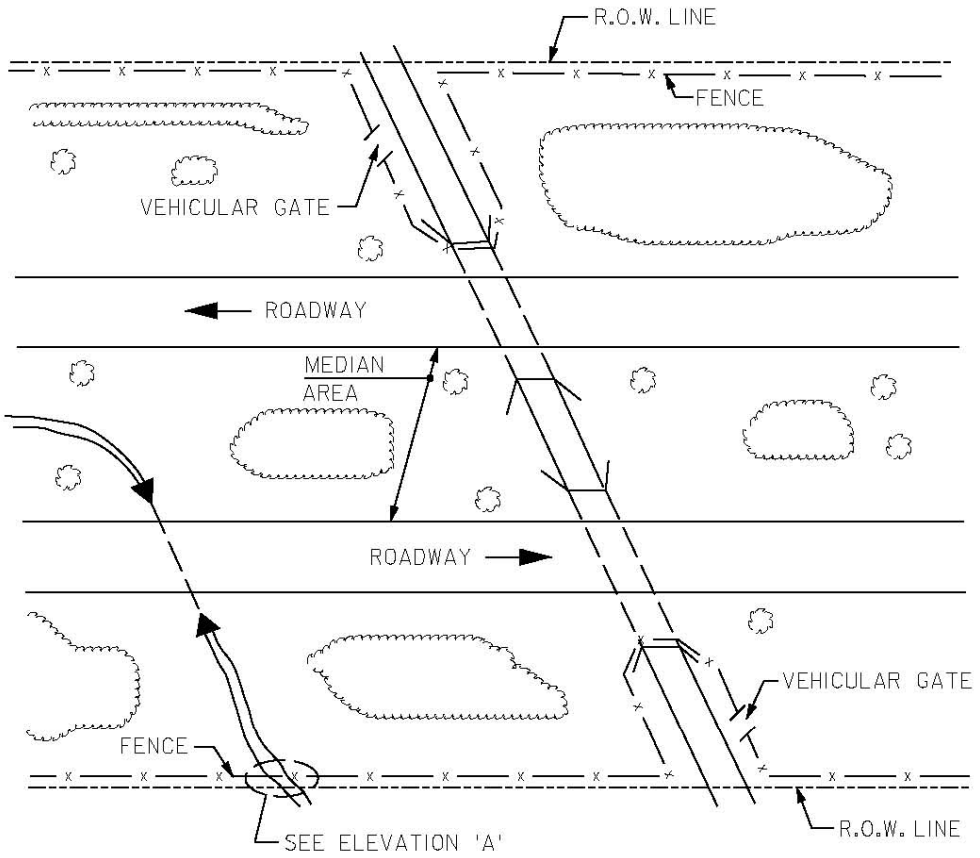
   a. Placement of fence with respect to the right of way line shall be as per the Standard Drawings.

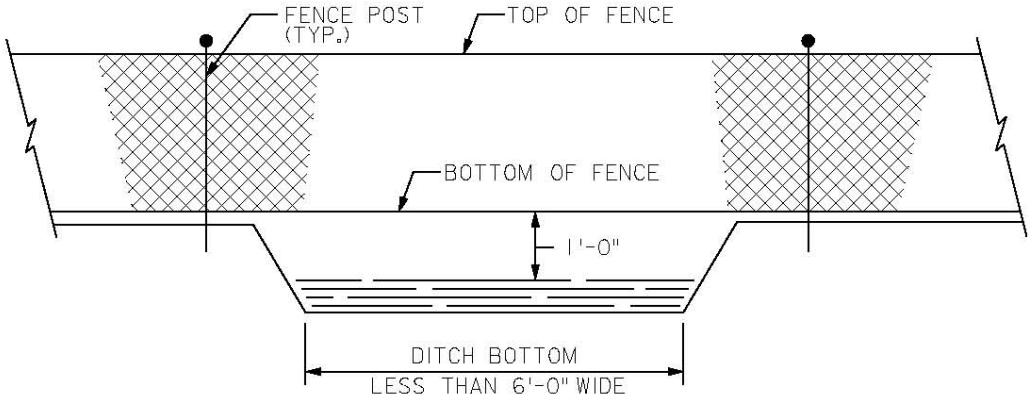
   b. Fence intersecting waterways which have a bottom width of 6 feet or greater will be turned and run parallel to the stream, along the top of bank, to the culvert headwall through the roadway embankment. Fencing will then be carried up behind the wingwall, across behind the headblock and back out to the right of way along the far side of the waterway. The median area crossed by the waterway will not be fenced. On one selected side of that portion of the fence running perpendicular between the ROW and roadway embankment, the engineer shall consider placing a single vehicular gate.

   c. Vehicular gate dimensions shall be as shown on the Standard Drawings. These gates shall be placed on that side of each water course which affords best access for maintenance. Consideration is to be given to proximity of local road access, the extent of trees, vegetation and ground contour to determine if a gate is required and if so where it is to be placed.

   d. A right of way fence is to be carried across streams and ditches having less than a 6-foot bottom width. Line posts are to be spaced so that no post is erected in the bed or slopes of the ditch. The bottom of the fence shall provide for one foot freeboard above the ditch high water elevation. When the profile line of the fence bottom is greater than one foot above the high water elevation, the fence fabric shall be extended lower as necessary to maintain the specified freeboard across the width of the ditch. See Exhibit 1A - 46 for general fence placement criteria at streams and ditches.

EXHIBIT 1A - 46
STREAM FENCING CRITERIA





ELEVATION "A"